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ASEPTIC NECROSIS OF THE FEMORAL HEAD FOLLOWING TRAUMATIC DISLOCATION OF THE HIP

A REPORT OF NINE CASES *

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The recovery of a normal range of motion and freedom from pain, after the reduction of a traumatic dislocation of the hip and a short period of cast or traction immobilization, is generally interpreted as evidence of a complete recovery. In such instances, the patient is then permitted to bear full weight on the limb and to return to his occupation with the understanding that he is cured. This encouraging prognosis is not a safe one, for many of these individuals experience a recurrence of pain and progressive disability of the hip after months or, exceptionally, years of normal activity and unchanged roentgenograms. This reappearance of symptoms after an early period of apparent recovery is now known to be due to aseptic necrosis of the head of the femur, which had resulted from a disruption of a major portion of its blood supply at the time of the dislocation.

Forty-two cases of aseptic necrosis of the femoral head after traumatic dislocations of the hip are recorded as such in the literature. Thirty-five were in adults (Table I) and seven in children. The author wishes to add nine additional cases, and in particular to emphasize the importance of early diagnosis in order that the devitalized head may be adequately protected from weight-bearing during its revascularization and replacement by new bone.

The incidence of this complication in dislocation of the hip cannot be definitely stated, for statistics of end results are still not available on large series of cases. The only such report is that of Pfab who found two

* This paper is based on the material, first presented before the Chicago Surgical Society in April 1940, and forming a scientific exhibit at the Annual Meeting of The American Academy of Orthopaedic Surgeons held in New Orleans, January 1941.

instances of avascular necrosis in a follow-up study of twenty-four cases, or 8.3 per cent.

ETIOLOGY

The blood supply of the head of the femur in the adult is derived from the nutrient branches of the anterior and posterior circumflex femoral arteries which enter the epiphysis after passing through the capsule on the neck, and from the arteries of the round ligament. The vessels coming by way of the capsule are generally regarded as the more important, although Chandler and Kreuscher, Wolcott, Nordenson, and others have shown by anatomical studies that the arteries of the round ligament, passing into the head, are present in the majority of hips of all ages. There is some lack of evidence as to exactly which of the above vessels are injured when the head becomes necrotic. The round ligament is always torn when the femur is forcibly displaced out of the acetabulum, and probably in fractures of the floor with central displacement of the head. This may or may not give rise to necrosis, depending on the extent of the vessels from the round ligament to the head, and their collateral circulation with the arteries entering by way of the neck. It is also possible that the tear of the capsule may injure the vessels of the neck to a greater or lesser degree. In favor of the theory that the tear of the round ligament vessels causes the necrosis, is the known fact that the head may survive in case of complete fracture of the neck of the femur, proving that in such instances there is important blood supply by way of the ligamentum teres. On the other hand, when recognizable necrosis develops after dislocation, it is usually the entire head and some of the adjacent neck which is affected, and this favors the view that vessels of the neck may also have been injured. Further observations and especially pathological studies will be necessary in order to clarify this point.

PATHOLOGY

The histological alterations in the head, when it undergoes avascular necrosis and replacement following dislocation of the hip, appear to be similar to those seen, and confirmed by pathological examination, in necrotic heads after fractures of the neck of the femur followed by bony union. Axhausen, Phemister[24], and others have described in detail the pathological changes in such fractures which may be summarized as follows:

The entire head, including cortex, trabeculae, and marrow, becomes necrotic, with the exception of the articular cartilage which may survive in some cases. As the blood supply becomes re-established through union, the cancellous spaces of the head are progressively invaded from the neck, and to some extent from the round ligament, by a highly vascularized connective tissue. This invasion is followed by absorption of the dead bone and marrow, with simultaneous replacement by living bone and marrow through the process of creeping substitution. In the areas

TABLE I

ANALYSIS OF ADULT CASES RECORDED IN THE LITERATURE

Case	Author	Year	Age	Dislocation	Fracture of Acetabulum	Type of Reduction	Pain-Free Period	Interval between Dislocation and Diagnosis of Aseptic Necrosis	Results
1	Müller	1924	18	?	?	Closed	?	?	Florid Perthes' disease after 4 years
2	Bergmann	1931	52	Obturator	?	Closed	?	After many years	Wedge-shaped sequestrum without collapse of head. Good function
3	Dyes	1932	23	Obturator	None	Closed	2 years	2 years	Painful hip
4	Chandler and Kreuscher	1932	14	Central	Floor	Closed	6 months	?	Collapsed head and pain after 10 years
5	Giuliani	1933	39	Iliac	None	Closed	?	?	Deforming arthritis after 6 years
6	Stewart	1933	21	Iliac	None	Closed	Pain persisted	1 year	Collapsed head and pain after 16½ months
7	Gerber	1933	17	?	?	Closed	?	1 year	Painful deformed hip
8	Gerber		23	?	?	Closed after 17 days	?	1 year	Spontaneous ankylosis
9	Phemister	1934	14	Iliac	Posterior rim	Closed	Pain persisted	11 months	Replacement after 1 year and 7 months. Good function after 2 years and 4 months
10	Waldenström	1936	23	?	None	Closed	6 months	?	Collapsed head and pain after 2 years; arthroplasty

TABLE I—*Continued*

Case	Author	Year	Age	Dislocation	Fracture of Acetabulum	Type of Reduction	Pain-Free Period	Interval between Dislocation and Diagnosis of Aseptic Necrosis	Results
11	Bunne	1936	44	Obturator	None	Closed after 4 months	?	10 months	Not stated
12	Küster-Zesas		16	?	?	Closed	?	1 year	Not stated
13	Blumensaat	1936	33	Obturator	None	Closed	5 weeks	6 months	Collapsed head and pain after 3 years and 11 months
14	Blumensaat		55	Obturator	None	Closed	3 months	8 months	Collapsed head and pain after 2 years
15	Blumensaat		60	Iliac	Posterior rim	Closed	3 months	3 months	Collapsed head and pain after 2 years
16	Massart et Vidal	1936	27	Iliac	None	Closed	1 year and 6 months	3 years	Painful, deformed hip
17	Kaijser	1936	26	Iliac	None	Closed	2 years	?	Painful, collapsed head after 6 years
18	Del Campo y Prat	1937	46	Ischiatic	None	Closed	1 year	1 year and 8 months	Painful, deformed hip
19	Funsten, Kinser, and Frankel	1938	48	Iliac	Posterior rim	Closed, traction 6 weeks	?	?	Painful hip after 6 years
20	Funsten, Kinser, and Frankel		46	Iliac	Rim	Traction 10 weeks	?	?	Fair, after 6 months

21	Funsten, Kinser, and Frankel		46	Iliac	None	?	?	1 year and 3 months	Resection of head
22	Funsten, Kinser, and Frankel		23	Iliac	Rim	?	?	8 months	Shelf operation. Head partly redislocated after 8 months
23	Pfab	1938	19	Iliac	None	Closed	?	?	Painful, deformed hip
24	Pfab		57	Iliac	Rim	Closed	?	?	Painful hip
25	Potts and Obletz	1939	34	Iliac	None	Closed	3 years	?	Painful, deformed hip; arthrodesis
26	Potts and Obletz		31	?	None	Closed	5 years	?	Painful hip; arthrodesis
27	Potts and Obletz		19	?	None	Closed	3 years	?	Painful hip; arthrodesis
28	Potts and Obletz		20	?	None	Closed	3 years	?	Arthroplasty
29	Potts and Obletz		30	?	None	Closed	2 years	?	Arthroplasty
30	Kleinberg	1939	15	Iliac	None	Closed	8 months	?	Painful, deformed hip
31	Kleinberg		19	?	None	Closed	7 months	?	Painful hip
32	Birch-Hirschfeld	1939	12	Iliac	None	Closed	Several months	3 years and 5½ months	Pain, collapsed head after 4 years and 9 months
33	Phemister	1940	61	Iliac	Posterior rim	Closed	6 months	9 months	Pain, deformed head
34	Watson-Jones	1940	?	?	?	?	?	?	Deformed hip
35	Walker	1940	23	Anterior	None	Closed	?	?	Collapsed head after 2 years

of transformed bone, the trabeculae are irregularly arranged and less dense than is the adjacent unreplaced dead bone, thus making it possible to distinguish such regions in the roentgenograms. All osseous elements in circumscribed areas may be completely replaced by fibrous tissue, producing cystlike zones of reduced density in the roentgenogram.

When the zone of transformation approaches the peripheral portions of the epiphysis, the bony articular cortex also becomes absorbed along with the subcortical bone, but subsequently may be irregularly replaced. Articular cartilage obtains a portion of its nutrition from the synovial fluid, and its chances of survival are enhanced if there is rapid revascularization of the underlying dead bone. If cartilage necrosis occurs, there is overgrowth by fibrous tissue or fibrocartilage.

An osteo-arthritis is frequently superimposed upon the necrotic head, and this condition is characterized pathologically by a villous synovitis, acetabular sclerosis, marginal osteophytes, and occasionally the formation of loose bodies in the joint.

Necrosis following dislocation has been diagnosed mainly on the clinical course and roentgenographic appearance of the hip. It must be emphasized that while death of the femoral head occurs shortly after the dislocation, it cannot usually be detected by roentgenograms at the end of six weeks when the patient is ready to resume walking. This is because the early roentgenographic diagnosis of a dead femoral head is dependent upon marked disuse atrophy of the adjacent living bone of the shaft and pelvis. Since the necrotic head without blood supply cannot participate in this decalcification, it will retain its original density and cast a shadow of greater intensity in the roentgenograms than will the surrounding living bone. Ordinarily, three to four months are required for sufficient atrophy to occur before this contrast between the living and dead bone is distinguishable in roentgenograms. As walking is usually resumed within six weeks of traumatic dislocation, there is insufficient time for density differences to develop between the dead head and the living shaft, and the complication temporarily goes unrecognized. The patient resumes full activity and continues to bear weight on the devitalized head until late changes, due to collapse or degenerative arthritis, cause the return of hip pain. This is usually the first clinical indication that epiphyseal necrosis has followed the dislocation. Roentgenograms will now show late evidence of necrosis, in the form of progressive replacement of avascular dense bone by less dense, irregular, living bone, alterations in the shape of the head following collapse or fragmentation, or signs of a deforming arthritis.

The following case reports will illustrate many of these features. The first patient demonstrates the typical clinical course and roentgenographic findings when the necrotic head is detected before it has undergone collapse or fragmentation, and when it is adequately protected from weight-bearing during its transformation.

CASE 1. W. H., male, aged twenty-four, sustained a posterior dislocation of the left hip in an automobile accident (Fig. 1-A). Immediate reduction was successful and nor-

FIG. 1-B

Roentgenogram after thirteen months showed slight flattening of superior surface of the femoral head (*a*). Note the absence of density difference between the dead head and the living shaft.

FIG. 1-A

Roentgenogram showing recent posterior dislocation of the left hip without fracture of the head or acetabulum.

FIG. 1-C

Roentgenogram after twenty-seven months revealed partial replacement across base, and inferior, medial, and lateral portions of the head. The wedge-shaped, proximal necrotic zone (*a*) remained unvascularized.

mal function was recovered after three weeks of plaster immobilization. Then, after nine months of unlimited use of the hip, pain returned, first after active exercise and subsequently after prolonged standing, as was necessary in his work as a press feeder. A roentgenogram of the pelvis at that time showed a small triangular shadow of bone in the soft tissues proximal to the greater trochanter, and minimal flattening of the head in its weight-bearing region. The pain gradually became worse and was moderately severe when the patient was first examined in the Clinic thirteen months after the dislocation, and four months after the reappearance of symptoms. The gait was normal, but motion was limited in all directions by muscle spasm, and pain could be elicited on extreme flexion.

Roentgenograms (Fig. 1-B) showed slight but definite flattening of the head of the left femur in its proximal portion and slight diminution in the articular cartilage space. Its density corresponded to that of the surrounding bone, which did not show atrophy of disuse, and the entire shadow of the bony articular cortex was unchanged.

In view of the previous dislocation and the presence of flattening at the top of the epiphysis, a diagnosis of aseptic necrosis of the head of the femur was made. Weight-bearing on this extremity was avoided for the following thirty-one months by means of crutches, in an endeavor to prevent further collapse of the fragile dead head while it was being transformed.

Roentgenograms (Fig. 1-C), taken twenty-seven months after the dislocation, showed replacement across the base and inferior mesial portion of the head, as indicated by its diminished and irregular density, which corresponded more or less to the then

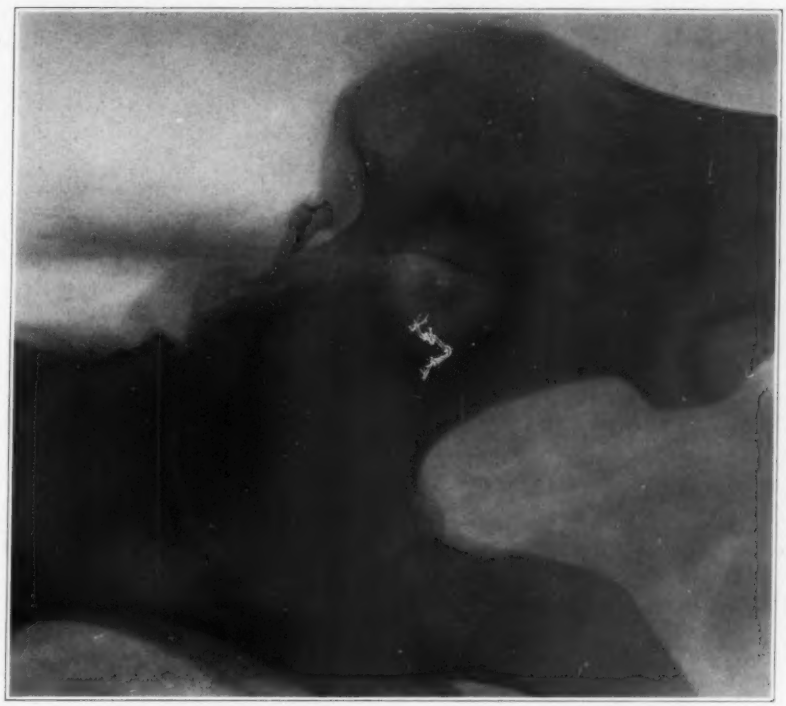

FIG. 1-E

Roentgenogram forty-three months following dislocation and thirty-four months after return of pain revealed final restoration of the head. Note the absence of fragmentation of the epiphysis or evidence of arthritis.

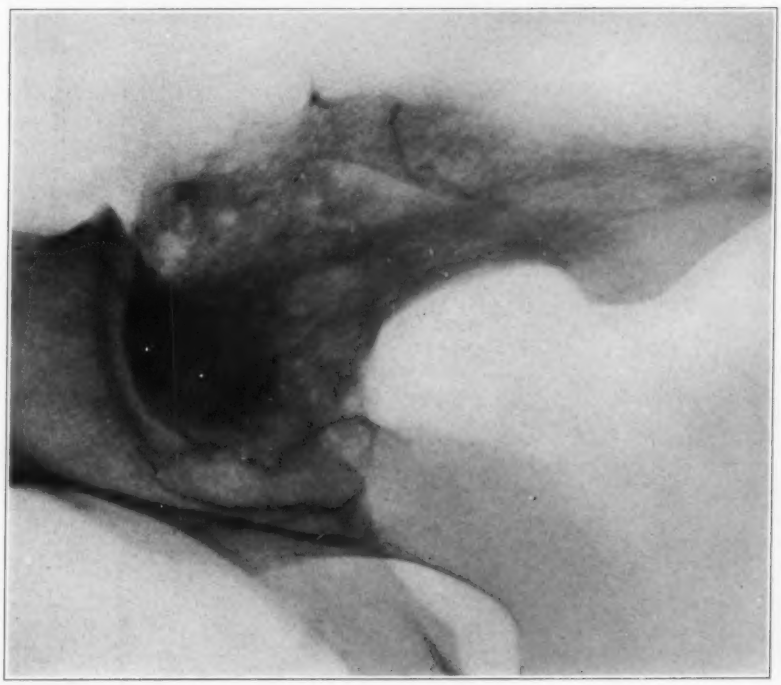

FIG. 1-D

Roentgenogram after thirty-three months showed further reorganization of the head. Dead area at the top of the epiphysis was smaller in size and more irregular in density.

FIG. 2-A

Roentgenogram showing fracture of the anterior margin of the acetabulum with posterior dislocation of the hip.

FIG. 2-B

Roentgenogram four weeks after injury showed incomplete reduction of the femur, but its head was smooth in outline and of normal density.

FIG. 2-C

Roentgenogram after eighteen months revealed advanced replacement of the inferior medial portion of the head while the proximal two thirds was necrotic and uninvaded.

atrophic living bone of the left femoral shaft and ilium. The proximal half of the epiphysis was dead, as its density remained unchanged and was similar to that of the non-atrophic right hip.

Roentgenograms (Fig. 1-D), taken thirty-three months after the injury, revealed absorption of the articular cortex over the mesial and lateral portions of the epiphysis, indicating that the centrifugally directed process of revascularization had reached the periphery of the head in those regions. The articular cortex remaining over the triangular shadow of devitalized bone in the weight-bearing region, on the other hand, was unchanged in density and outline.

Roentgenograms (Fig. 1-E), forty-three months following the dislocation and thirty-four months after the return of pain, showed final replacement of the head with the probable exception of a small linear area across the superior surface. The cartilage space was well maintained and roentgenographic evidence of a degenerative arthritis was limited to marginal lipping.

The patient is now bearing partial weight on the extremity without pain, while hip motion is restricted except for flexion and extension.

It is to be noted that adequate protection of the epiphysis from weight-bearing by means of crutches during its reorganization eliminated pain and prevented further compression or fragmentation of the head. The present anatomical and functional result is good.

FIG. 2-D

Roentgenogram six and one-half years after dislocation showed marked collapse of the head in its weight-bearing portion, and extensive deforming arthritis.

When the patient is not forewarned of the possibility of late pain in the hip, and continues to bear weight on the extremity for prolonged periods after the return of symptoms, the head may undergo marked collapse with depression of the articular surface, particularly at the points of maximum pressure. These changes are at times irreparable and result from compression of dead trabeculae, or fractures through necrotic old or fragile new bone. Fractures are prone to occur through devitalized bone just proximal to the zone of transformation after a major portion of the head has been replaced and walking continues.

If such a fracture occurs, and the proximal dead fragment becomes reattached to the head, it may readily be invaded by connective tissue and replaced by new bone in a relatively short time. On the other hand, when a non-union develops between the fractured fragment and the rest of the head, the former persists as a sequestrum at the top of the epiphysis for a prolonged period. In rare instances, fibrous tissue overgrows the contacting surfaces of sequestrum and head, resulting in a pseudarthrosis as was described by Kraft in a case of Legg-Perthes disease, and by

Phemister [26] in a dead head after a fracture of the neck of the femur. Naturally, this prevents invasion of the dead fragment, and years may be required for final restoration of the head, as is illustrated by Case 4.

The next four cases demonstrate the prolonged disability and poor functional results which follow traumatic dislocations of the hip, when the necrotic head becomes greatly altered in shape, or a sequestrum forms in its weight-bearing region.

CASE 2. W. T., male, aged thirty-seven, received a dashboard dislocation of the left hip with an associated fracture of the anterior medial margin of the acetabulum (Fig. 2-A). Closed reduction was performed and the extremity maintained in extension for eight weeks. A roentgenogram (Fig. 2-B) taken four weeks after the injury showed moderate persisting upward displacement of the femur, due to inadequate reduction. The head appeared smooth in outline and of normal density. Crutches were used for two months following the period of recumbency and then a cane. Mild pain and stiffness persisted in the hip. This was increasing when the patient entered the Clinic eighteen months after the acute injury. Examination revealed marked atrophy and weakness of the thigh muscles, and his weight could not be maintained on the involved extremity.

The roentgenogram (Fig. 2-C) showed the upward displacement of the left femur with loss of cortical shadow over the acetabulum. The head appeared smaller than that of the normal right femur, and its medial third was irregular in outline. The proximal two thirds of the head was necrotic, as indicated by the persistence of its normal density, the trabecular pattern, and the shadow of the articular cortex. The medial portion and a small area on the lateral side had been partially replaced, as suggested by its spotty reduced density and the absorption of the overlying articular cortex. The linear density proximal to the head and neck represented extensive ossification in the capsule.

The presence of aseptic necrosis of the head of the femur was evident. A surgical arthrodesis was advised in view of the patient's disability and the alterations in the hip joint. He refused operation and was not seen again for five years.

During this interval he maintained less than half-time employment because of pain in the hip. Physical examination now showed further flexion and adduction deformity, and motion was restricted and painful.

Roentgenograms of the hip (Fig. 2-D) taken six and one-half years after the dislocation revealed a flattened and irregular head of the left femur with loss of substance in its weight-bearing region. Transformation of the head was completed, for it was of an irregularly reduced density corresponding to the persisting regional atrophy of the femur and ilium, and the shadow of articular cortex was entirely absent. An extensive proliferation of new bone along the posterior acetabular margin and throughout the capsule gave the head a mottled appearance on the single roentgenogram.

Operation was again refused by the patient, although the hip was exceedingly painful and functionally poor.

CASE 3. H. H., male, aged forty-three, suffered a comminuted fracture of the left ischium with posterior dislocation of the femur, when a mass of iron ore fell on his hip. Reduction was performed under a general anaesthetic and the hip immobilized for six weeks in a plaster dressing. Full functional use of the extremity soon followed and continued without pain for fifteen months. A roentgenogram (Fig. 3-A), taken five months after the accident, showed satisfactory healing of the fracture and no abnormalities in the head of the femur.

Physical examination two months after the reappearance of symptoms, during which time weight-bearing had continued, showed considerable muscle spasm about the hip, and limitation of motion in all directions. A roentgenogram disclosed a diminution in the cartilage space and marked flattening and irregularity in the outline of the head.

FIG. 3-A

Roentgenogram five months after posterior dislocation of the hip showed satisfactory healing of fractured left ischium and no abnormalities of the femoral head.

FIG. 3-B

Roentgenogram after twenty-two months showed a disc of dead bone (*a*) at top of the head, separated from hypertrophied replaced bone (*c*) by band of decreased density (*b*). Note the large exostosis at the lateral margin of the epiphysis.

FIG. 3-D

Roentgenogram seven years after injury showed an extensively deformed hip joint.

FIG. 3-C

Roentgenogram after thirty-five months revealed invasion and organization of sequestrum with loss of cartilage space.

FIG. 4

Roentgenogram five years after return of pain and seven years after dislocation showed old sequestrum (*a*) which had been invaded and transformed, but was still separated from the remainder of the head by a zone of transformation (*b*). Note the hypertrophy of the replaced bone (*c*) across top of the epiphysis in response to the sequestrum, and over the mesial third, due to weight-bearing.

The upper half was dead, as shown by its spotty increased density, when compared to that of the lower half. The latter was undergoing transformation and its diminished density corresponded to the adjacent osteoporotic living bone. There was sclerosis of the acetabular margin, while bone formation in the capsule and along the superior margin of the neck was prominent.

The hip was protected by a non-weight-bearing caliper brace for eight months. The pain subsided and the range of motion gradually increased.

Transformation of the necrotic head was followed in roentgenograms. One, taken twenty-two months after the dislocation (Fig. 3-B), showed at the top of the head a flat irregular disc of dead bone which had become separated from the main osseous portion of the epiphysis by a band of decreased density corresponding to the zone of absorption. There had been further transformation of the inferior mesial portion of the head, as indicated by its more uniform diminished density and the loss of the overlying shadow of articular cortex. Its upper dense margin represented hypertrophy of newly formed bone, probably secondary to the presence of the sequestrum. The bony projection from the lateral portion of the head was definitely limiting abduction of the extremity.

Roentgenograms of the pelvis (Fig. 3-C), taken thirty-five months after injury, showed further reorganization of the head, including the sequestrum, while the trabecular pattern, particularly in the distal portion, was reforming.

The patient was first examined in the Clinic seven years after the dislocation. He

FIG. 5-B

Roentgenogram after three and one-half years revealed collapse of the head with sclerosis of the underlying bone and secondary arthritis.

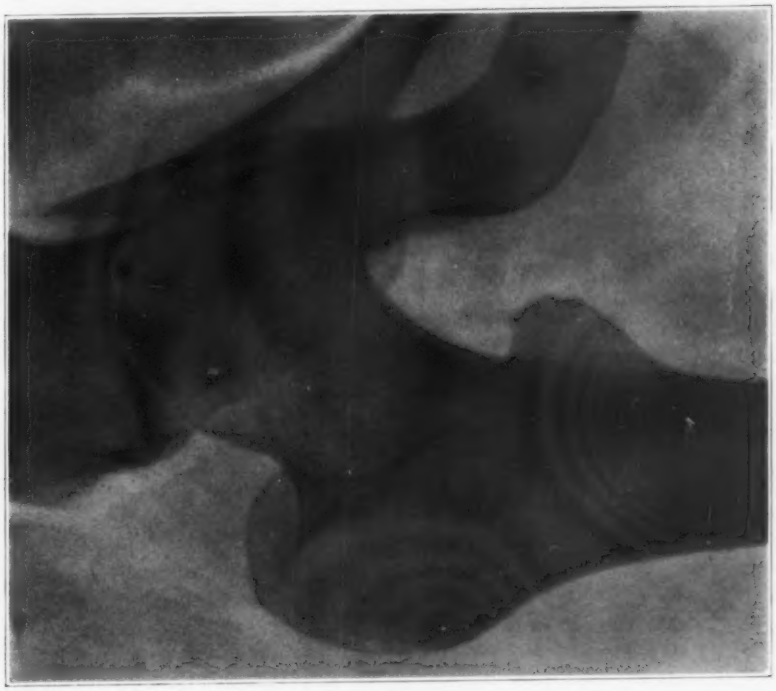

FIG. 5-A

Roentgenogram showed a recent fracture of the base of the acetabulum with central dislocation of the hip. The femoral head appeared normal in shape and density.

had continued his employment as a metallurgist, and used a crutch while at work and a cane at other times. Flexion of the hip was free to 90 degrees, while abduction and adduction were negligible and painful. Stereoscopic roentgenograms (Fig. 3-D) revealed complete transformation of the head, which had undergone marked collapse with a resulting irregular, flat superior surface. The ossification within the capsule overlying the head gave it a mottled appearance on the single film. Acetabular sclerosis and marginal new-bone formation indicated a far-advanced secondary osteo-arthritis.

The patient was satisfied to continue the use of a cane or a crutch, and refused to consider arthrodesis.

CASE 4. L. C., male, aged forty, sustained a traumatic dislocation of the left hip. After reduction and three weeks of immobilization in a plaster dressing, the patient enjoyed normal use of the extremity for two years. Pain then returned and increased gradually during the next five years with marked disability.

A roentgenogram (Fig. 4), taken seven years after the acute injury, showed an irregularly deformed femoral head with loss of cartilage space, secondary sclerosis of the acetabulum, and the formation of marginal osteophytes. The shadow of the entire old articular cortex was absent. A dense shadow in the weight-bearing region apparently represented a portion which had become separated from the remainder of the head as a result of a pathological fracture with subsequent invasion and transformation. Below this old sequestrum, and in response to its presence, the replaced bone had undergone hypertrophy, and its shadow was denser than that of the surrounding living bone. The marginal sclerosis over the medial third of the head, in response to weight-bearing, and the restoration of trabecular pattern in the transformed areas were striking.

CASE 5. H. B., female, aged sixty-eight, sustained an injury to the right hip when she was struck by an automobile. A roentgenogram (Fig. 5-A), taken immediately, showed a fracture of the base of the acetabulum with central dislocation of the hip. The shadow of the femoral head was normal in shape and density. The extremity was elevated on pillows for six weeks with no attempt at reduction. The hip remained painful after the period of recumbency, and full activity could not be resumed.

The patient used the hip in spite of pain, and did not seek further medical aid for three years. Roentgenograms, obtained at that time, showed the site of the previous fracture to be well healed, but the deformed femoral head was slightly centrally displaced with loss of its superior articular portion and narrowing of cartilage space. Marked sclerosis had occurred along the irregular acetabular margin. The reduction in density of the greater portion of the head corresponded to that of the surrounding atrophic living bone, and there was marked thinning of its overlying cortex. The area of increased density at the region of collapse was due to hypertrophy of replaced bone in response to weight-bearing.

The patient was first admitted to the Clinic three and a half years following the dislocation. Her chief complaint was pain in the hip. Physical examination disclosed a right hip limp and extreme muscle atrophy of the thigh. Abduction, as well as adduction, was negligible and painful, while flexion was unrestricted.

Roentgenograms (Fig. 5-B) showed the hip to have changed little in appearance since the last examination. It was evident that aseptic necrosis of the head of the femur had resulted from a loss of a major portion of its blood supply at the time of the injury. Restoration of the dead head had apparently been completed, but weight-bearing during the period of reorganization had caused collapse at the point of maximum pressure. It is interesting to note that this had not occurred at the top of the head, but over the lateral surface where the full weight of the body was being borne because of the slight persisting central displacement of the femur.

Surgery was contra-indicated in view of the patient's age and general physical condition, but the hip pain was relieved by crutches. Roentgenograms taken seven months later showed no change in the appearance of the femoral head.

FIG. 6

Roentgenogram showed iliac dislocation of eighteen years' duration and healed fracture of the acetabulum. The necrotic femoral head had been transformed except for the calcified central dead portion (*a*).

The next case affords further evidence that unprotected walking on the devitalized head is responsible for the collapse and alterations in its contour. In this instance, reposition of an iliac dislocation was not accomplished and, although the patient resumed walking on the limb, the shape of the head remained unmodified. This is to be explained by the fact that the superincumbent body weight was not transmitted directly onto the head through the medium of the acetabulum. The case is of additional interest because the necrotic central portion of the head had apparently remained unreplaced, and subsequently calcification occurred similar to that described by Phemister [25] in a devitalized head following an intracapsular fracture of the femur, and by Kahlstrom, Burton, and Phemister [14] in large, aseptic, bone infarcts resulting from caisson disease.

CASE 6. S. K., male, aged fifty-five, was first seen in the Orthopaedic Clinic because of pain, referable to the lumbosacral spine and left gluteal region, of six months' duration. Eighteen years previously he had been in a railroad accident and suffered multiple fractures of the pelvis and a posterior dislocation of the left hip which had not been reduced. He remained in the hospital for one year, during which time he gradually became ambulatory and was able to bear full weight on the left leg, although there was some insta-

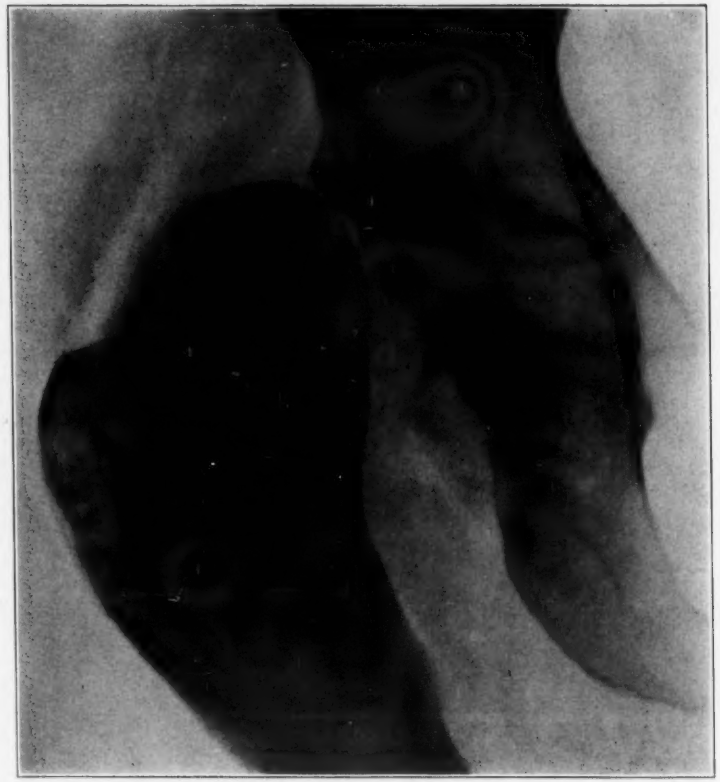

FIG. 7-A

Roentgenogram showed posterior dislocation of the right hip and fracture of the mesial portion of the head.

FIG. 7-B

Roentgenogram twenty months after dislocation showed an irregular fragment of bone beneath the inferior medial surface of the head and neck.

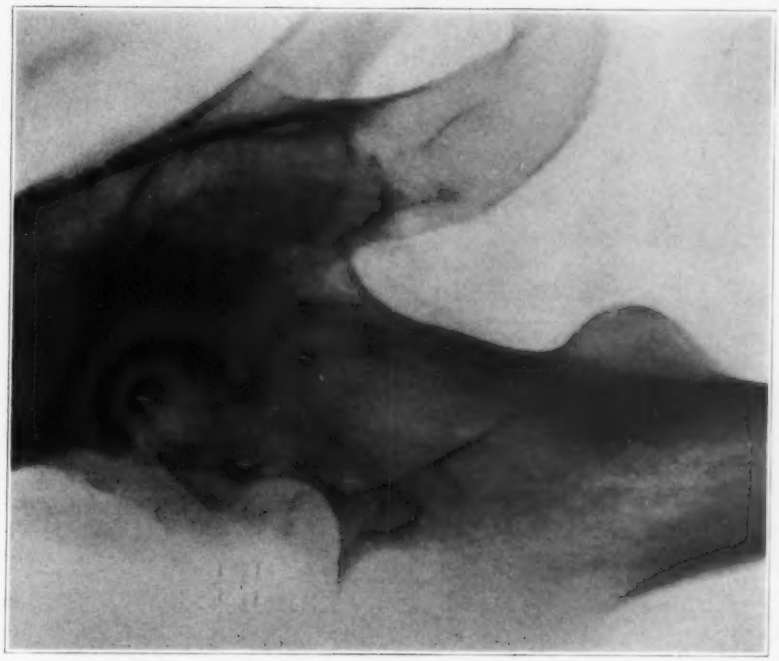

FIG. 7-D

Roentgenogram five years after dislocation showed irregular density of the head, diminution in cartilage space, and secondary arthritis.

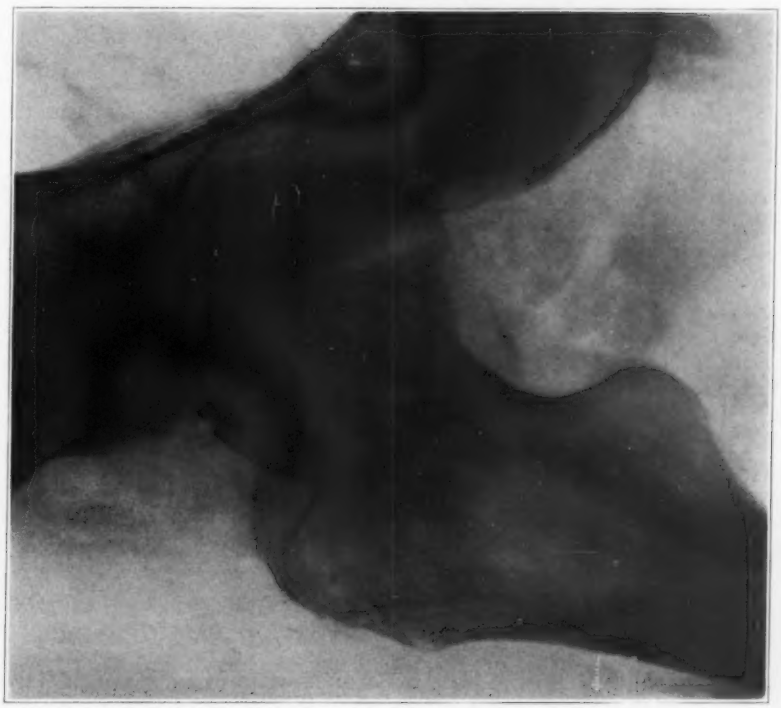

FIG. 7-C

Roentgenogram after surgical removal of bone fragments revealed no alteration in the femoral head.

FIG. 8-A

Roentgenogram showing fracture of the posterior wall of the acetabulum. The femoral head is unchanged in shape and density.

bility. Physical examination on admission to the Clinic revealed a left hip limp, a mild right lumbar scoliosis, and the left leg to be four inches shorter than the right. Motion of the hip was full and painless.

Stereoscopic roentgenograms of the pelvis (Fig. 6) showed the head of the left femur to be displaced from the acetabulum and riding high on the posterior surface of the ilium. The outline of the head was smooth but indistinct, following irregular absorption of the bony articular cortex. The diminished density of the peripheral portion of the epiphysis was similar to that of the atrophic shaft of the femur, and was in marked contrast to the calcified central dead portion which produced a dense irregular shadow two by one and five-tenths centimeters on the roentgenogram. The increased density of the medial portion of the neck was not related to the central density in the head, but was due in part to the hypertrophy of the trabeculae along new lines of weight-bearing force, and in part to the superimposition of a portion of the ischium. The acetabulum was obliterated and deformed as the result of a healed fracture; and the right pubic bone was the site of two previous fractures.

The next case illustrates the reappearance of pain four and a half years after a traumatic dislocation of the hip.

FIG. 8-B

Roentgenogram after thirty months revealed a flattened head of mottled density and far-advanced osteo-arthritis.

CASE 7. A. A., male, aged fifty, sustained an injury of the right hip when he was caught in a moving belt of a conveyor. A roentgenogram taken then revealed a posterior dislocation of the hip and a fracture of the mesial portion of the head (Fig. 7-A). The dislocation was reduced immediately, and, after sixteen weeks, the patient was able to resume his former occupation. He stated that during the next fourteen months the hip remained symptom-free, and he had unlimited use of the extremity. Pain then recurred spontaneously, and was marked when he was first seen in the Clinic twenty months after the dislocation. Roentgenograms (Fig. 7-B) then showed a shadow of bone density at the inferior border of the head and neck, which was interpreted as a chip fracture of the head. This was verified at surgery when the small osseous fragment was found loosely attached to an incompletely obliterated defect on the posteromesial surface of the head.

Roentgenograms (Fig. 7-C), taken immediately after surgery, showed only a small spicule of bone remaining beneath the inferior margin of the neck. The head appeared normal in outline while the joint space and acetabulum were unaltered.

The patient wore a non-weight-bearing caliper brace for six weeks following the operation, after which the hip was entirely painless and motion was only minimally restricted. He did not return to the Clinic again for three years. Six months previous to this, pain had returned in the hip for a second time and had prevented him from working.

FIG. 9-A

Roentgenogram obtained soon after primary injury showed an obturator dislocation of the left hip.

FIG. 9-B

Roentgenogram after fifteen months showed areas of replacement about the periphery of the head, while the remaining central dead portion was extremely dense.

FIG. 9-C

Roentgenogram after twenty-two months showed complete restitution of the osseous center, except for several linear streaks of necrotic bone.

FIG. 9-D

Roentgenogram after six years and two months revealed a flattened but smooth head with maintenance of the joint space. Note the absence of secondary arthritis.

Roentgenograms (Fig. 7-D), taken five years after the dislocation and approximately three years after the arthrotomy, showed irregular areas of increased and decreased density throughout the slightly flattened head of the femur. The articular cortex had been absorbed over the medial portion of the epiphysis where a large area of diminished density extended up to the joint surface. At the lateral margin there was a triangular shadow of apparent new-bone formation. The cartilage space was diminished in width with sclerosis of the acetabular margin. Arthrodesis was advised, but refused.

Spontaneous reduction of a subluxation of the hip occasionally occurs immediately following the acute trauma, or as the patient is being transported to the hospital. The initial roentgenograms may, therefore, appear entirely normal. However, if the displacement of the femur was of sufficient magnitude, capsular vessels, as well as vessels of the ligamentum teres, may be torn to such an extent that aseptic necrosis of the head results, and the patient experiences late pain and progressive disability of the hip. A patient of Dr. H. Gordon Heaney of Corpus Christi, Texas, appears to have presented such a sequence of events, although roentgenographic proof of the subluxation is lacking.

CASE 8. L. L. W., male, aged thirty, injured the left hip in an automobile accident. Roentgenograms (Fig. 8-A), taken the day of the accident, showed a linear fracture of the posterior margin of the acetabulum, but no changes in the femoral head. Full use of the extremity followed a short period of bed rest. Then, after thirty months, pain in the hip returned and grew progressively worse as walking was continued.

Examination showed limitation of flexion and pain on rotation of the leg. Roentgenograms (Fig. 8-B) revealed a flattened head of mottled density with irregular absorption of the articular cortex, while the cartilage space was markedly diminished in width. Sclerosis of the acetabular margin and new-bone formation about the acetabulum and head indicated a far-advanced secondary arthritis.

A diagnosis of aseptic necrosis of the femoral head following a traumatic subluxation of the hip was made, and the patient was advised to use crutches. Pain and disability persisted and a vitallium-cup arthroplasty was performed.

Traumatic dislocations of the hip are occasionally encountered in young children. Seven patients whose dislocations were followed by death of the femoral head have been recorded [9, 13, 21, 28, 30, 33] as such in the literature. The roentgenographic changes during replacement of the head appear somewhat similar to those observed in Legg-Perthes disease, and the immediate end results are equally satisfactory. The osseous center undergoes necrosis with subsequent invasion and transformation.

When the femoral head in older children becomes necrotic [3, 6, 16, 24], the pathological alterations simulate those seen in adults and the results are equally poor. This appears to be true whether the primary pathological condition was a traumatic dislocation, a fracture of the neck of the femur, or a slipping of the upper femoral epiphysis.

Case 9 illustrates the changes associated with aseptic necrosis of the femoral head after traumatic dislocation of the hip in a child.

CASE 9. F. F., male, aged twelve, a patient of Dr. Frank D. Dickson's, sustained an obturator dislocation of the left hip without an associated fracture of the femur or acetabulum (Fig. 9-A). The hip was immobilized in a plaster dressing following closed reduction, and the patient's recovery was complete. Fifteen months later, pain returned,

and roentgenograms (Fig. 9-B) showed a mottled appearance of the head not unlike that seen in Legg-Perthes disease. There were numerous small areas of osteoporosis about the periphery of the capital epiphysis where replacement had already occurred, while the central, unrestored, dead portion was extremely dense. The cartilage space was unchanged in width and the acetabulum appeared normal.

Further weight-bearing was prevented, and roentgenograms (Fig. 9-C), taken seven months later, showed restoration of the epiphysis except for several linear areas of dead bone persisting in the central portion. The shadow of the articular cortex was absent, and the ossification center of the head was slightly decreased in height. Apparent interference with growth at the epiphyseal plate had resulted in a shortened and broadened neck with relative upward displacement of the greater trochanter. In spite of the changes in the osseous center, the cartilage space corresponded in width to that of the right hip.

The subsequent course showed final reorganization of the bone epiphysis, and the patient's functional recovery remained good six years and two months after the injury. Roentgenograms (Fig. 9-D) then showed the head to be somewhat flattened, but relatively smooth in outline, while the joint space was well preserved, and there were no arthritic changes.

END RESULTS AND TREATMENT

Any patient who sustains a traumatic dislocation of the hip may develop late changes in it, due to aseptic necrosis of the femoral head. Of the forty-three recorded cases in older children and adults, thirty-nine have resulted in deformed and painful or ankylosed hips. In each of these instances, the head had undergone extensive collapse or fragmentation before the patient returned for medical care after the period of apparent recovery, or before the primary pathological condition was recognized. This demonstrates the importance of early diagnosis, and the necessity for adequate protection of the fragile, devitalized head during its restitution, if the prognosis in these cases is to be improved. Since the presence of a dead head cannot usually be detected soon after the initial injury, either by clinical or roentgenographic examination, the physician may approach the problem of early diagnosis in one of two ways, as follows:

Whenever possible, the extremity may be protected from weight-bearing by means of crutches for four to six months after the postreduction period of immobilization or recumbency. If the femoral head undergoes uniform atrophy of disuse and no density difference develops between it and the then osteoporotic living bone of the shaft and the ilium, as shown by roentgenograms, the patient may resume full weight-bearing with the likelihood that the head has remained alive, although roentgenographic follow-up should continue for an additional twelve months. However, if the head is thus shown to be necrotic, early protection can be provided and continued until serial roentgenograms show final revascularization and replacement by new bone.

On the other hand, if the patient insists on walking six weeks after the dislocation without the aid of crutches, roentgenographic examination of the hip must be obtained at intervals over a period of at least two years, although the extremity may appear clinically intact. When the diagnosis becomes available before much damage to the head has occurred, weight-bearing should be prevented until replacement has been completed. If,

however, the hip is already the site of a marked deforming arthritis which precludes the possibility of a satisfactory outcome, an arthrodesis appears to be indicated.

While the end results have been almost uniformly bad in adults and older children, the outcome has been gratifying in eight young children in whom a traumatic dislocation of the hip was followed by aseptic necrosis of the femoral head.

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AN IMPROVED SHELF OPERATION AT THE HIP *

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The construction of a shelf over the head of the femur may be required in several kinds of instability of the hip joint, such as:

1. Older cases of unreduced congenital dislocation of the hip.
2. Successfully reduced congenital hip dislocations, where, in later life, the upper rim of the acetabulum fails to develop sufficiently to cover the femoral head (very properly called "dysplasia of the acetabulum").
3. Congenital subluxation of the hip, "in which there is a more or less pronounced displacement of the femoral head in the acetabulum, . . . but in which part of the head still lies in the acetabulum", as described by Wiberg.
4. Plastic changes in the shape of the femoral head, such as may occur in coxa plana (Legg-Calvé-Perthes disease), or other deforming conditions.
5. Certain cases of hip instability following arthroplasty, reconstruction operation, or the acute, suppurative epiphysitis of infancy.

Nearly all of the shelf operations hitherto described have involved turning down a flap of bone from the outer table of the ilium over the femoral head, and bracing this flap by small bone grafts placed between the flap and the ilium. This method is not mechanically sound. In adults and adolescents, the flap is apt to be fractured completely at the base while being turned down, and cannot be fixed in place with sufficient solidity. In such cases, traction and protection must be continued for a long time, in order to prevent upward displacement of the shelf. Even in children, where the flap undergoes only an incomplete, greenstick fracture, the mechanical fixation is not very secure. In addition to this objection, there is difficulty in placing the shelf directly above the femoral head. The author has seen many cases and many reports of cases where the shelf has been constructed at so high a level above the head that the operation has been of no value to the patient. Notwithstanding these disadvantages, this method has been widely used in American and foreign clinics, with slight and unimportant variations in technique, and has given excellent results in many cases. In Europe it is usually called Lance's method.

The tibial-peg shelf operation described by Compere and Phemister furnishes a strong and stable shelf, on good mechanical principles, but requires the removal of bone grafts from the tibia, and does not supply a smooth surface of cortical bone.

Hallock mentions the use of a free graft of bone from the ilium, driven in immediately above the femoral head. He does not state from what portion of the ilium the graft is removed, and the author does not think his procedure is exactly like the one here described. On June 10, 1939, a

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, New Orleans, Louisiana, January 14, 1941.

short report of the author's method was read at the celebration of the Seventieth Anniversary of the founding of the Boston Children's Hospital, but the report was not published.

During the last five years, a technique has been developed which seems better and simpler than any of the other operations that have been described. It is adapted particularly to patients over ten years of age.

PLAN OF OPERATION

A square or rectangular piece of the full thickness of the wall of the ilium is excised, and is then driven into a deep slot cut with a thick osteotome directly above the head of the femur. It needs no supporting struts or bone grafts to hold it in place. Only a short period of traction in bed is required, for, as soon as the incision is healed, the patient may be allowed to get up and walk about with crutches. Only one incision is needed. The large opening left in the wall of the ilium has not caused any disturbance, probably because the periosteum of the visceral side of the ilium is left intact and is reinforced by the strong iliacus muscle.

TECHNIQUE OF OPERATION

A Smith-Petersen incision is used to expose the anterior half of the ilium and the capsule covering the head of the femur. The capsule is not opened, but it may be stripped from the wall of the ilium if there is much upward displacement of the femoral head. The head may then be pulled down as much as is practicable.

A thick osteotome is now driven horizontally into the wall of the ilium just above the head of the femur, to a depth of one-half to three-quarters of an inch or more, depending upon the thickness of the ilium at the desired level. This slot is extended forward and backward sufficiently to correspond with the size of the femoral head, and is curved slightly like a shallow acetabulum. It can be cleaned out with a small curette through its entire length and depth (Figs. 1 and 2).

An area is now selected on the upper, curved surface of the wall of the ilium, just below the crest, and a rectangle of appropriate size is marked out by four drill holes at the corners. The drill is driven through the entire thickness of the ilium, including both tables of the bone. It is easy to do this with the hand drill operated at slow speed, and one can gauge accurately the depth of the bone at the different corners. A thin-bladed, half-inch osteotome is used to cut out the graft, which in older patients is about one and a half by two inches in size. The thickness of this graft will be found to vary considerably, being thicker in the portion nearer the acetabulum. It has a slightly curved surface, which makes it fit the femoral head with some degree of accuracy.

After the edges of the graft have been smoothed and the corners rounded, the thinner edge is driven firmly into the slot with a blunt impactor or a small hammer. If the graft projects farther than is necessary, it can be trimmed with a rongeur forceps. This shelf is so strong and

FIG. 1

Chisel cutting deep slot above femoral head.

FIG. 2

Slot completed. Full-thickness graft outlined on ilium.

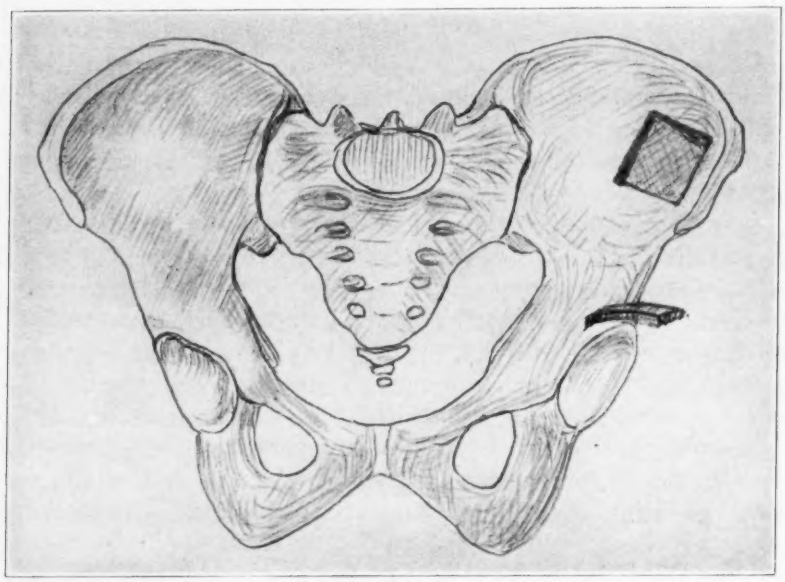

FIG. 3

Graft in place.

solid that no supplementary bone grafts are needed (Fig. 3). All bleeding is carefully checked, using Horsley's wax, if necessary, in the cut edges of the ilium. The incision is sutured in the usual manner, and a firm muslin spica bandage is applied over thick layers of sheet wadding.

The patient is put to bed with a Buck's extension of only sufficient weight to balance the muscle pull. It is not necessary to draw the femoral head away from the shelf.

Three weeks after the operation the patient may be allowed to sit up, and a few days later he may commence walking with crutches. From this time active and passive movement of the hip joint, without weight-bearing, should be performed daily for two or three weeks. If the roentgenograms then show good position and good nutrition of the graft, cautious weight-bearing may be allowed, and gradually increased.

It probably requires about three and one-half months from the time of operation for the graft to become entirely solid and vascularized.

CASE REPORTS

The first of these operations was performed in 1935, in a woman, thirty-two years of age, who had a unilateral congenital hip dislocation which had been unsuccessfully reduced by another surgeon in about 1905. She limped for thirty years, but had no pain or disability until after the birth of her second child, in 1933, when she began to have pain on walking. The head of the femur was about two inches above the acetabulum, and was freely movable. An operation was performed at St. Luke's Hospital, September 23, 1935. The graft was reinforced by two tibial pegs and an additional piece of ilium, as the wall of the ilium was too thin at this level to permit of a very deep slot. She made an uneventful recovery, and says that she can run rapidly up and down stairs without any pain whatever.

This case illustrates the use of the operation in an old, unreduced congenital dislocation.

Another type of hip dysfunction is represented by a woman of thirty-two years who, at the age of six, had been successfully operated upon, by another surgeon, for bilateral congenital dislocation of the hip. She was well and strong for the next twenty-six years, when the right hip became painful. She had two attacks of pain which disabled her for several weeks. Roentgenograms showed a shallow acetabulum, and a slightly flattened head which projected laterally beyond the rim, fully one-third of its diameter. The head of the opposite femur was anterior to its acetabulum, beneath the anterior spine of the ilium, and rested securely in a good socket. This hip had never been painful.

On November 2, 1938, a broad, strong piece of the ilium was implanted deeply above the femoral head, and was reinforced by two pegs from the tibia, as it was not known at that time that these grafts do not need any additional support. The result was completely satisfactory (Fig. 4). Two years have elapsed since the operation.

This case illustrates the dysplasia which sometimes follows a successful reduction of a congenital dislocation of the hip.

A third variety of dysplasia was seen in a woman, forty-two years old, who had had some kind of hip trouble as a small child, but no diagnosis had been made and no treatment had been attempted. She was married and had several children, and was able to do all of her housework until six months before reporting to the hospital. At that time, her right hip had become painful, and she was completely disabled by plastic changes, with a shallow and sloping acetabulum from which the head projected laterally about one-fourth of its diameter (Fig. 5-A). The exact cause of this condition cannot be determined at this late date, but it may have been a Legg-Calvé-Perthes osteochondritis.

On May 22, 1939, a strong, free graft from the ilium was driven deeply above the rim of the acetabulum. Fixation was so solid that no reinforcement was necessary (Fig. 5-B).

Roentgenograms made November 20, 1940, showed a solid shelf. The woman walks with no pain or disability, and is greatly pleased with the result. Two years have now elapsed since the operation (Fig. 5-C).

FIG. 4

Case 2. B. K. November 23, 1940, two years after operation. In addition to the large bone graft from the ilium, two small tibial pegs were inserted diagonally over the corners of the graft, as it was not then known that the graft does not need support when inserted into the ilium. The shadows of the pegs can be seen above the graft. Patient has complete relief of symptoms.

FIG. 5-A

Case 3. A. T. May 17, 1939, condition before operation.

FIG. 5-B

Case 3. A. T. August 16, 1939, three months after operation.

FIG. 5-C

Case 3. A. T. June 2, 1941, roentgenogram shows defect in ilium unfilled. Patient has complete relief of symptoms.

FIG. 6

Roentgenogram taken June 3, 1941, of patient on whom operation described was performed on July 15, 1939, by Dr. R. O. Ritter.

Several other patients on the author's Service have been operated upon in this manner. Figure 6 shows the result in one patient.

This method is simple and mechanically sound, and can be performed in a relatively short time. The convalescence is rapid, and the results have been extremely satisfactory.

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THE SIGNIFICANCE OF PHLEBOTHROMBOSIS AND THROMBOPHLEBITIS IN ORTHOPAEDIC SURGERY *

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In a previous publication[5], attention was directed to the distinction between thrombophlebitis and phlebothrombosis. In the former the intravascular clotting is associated with, and dependent upon, inflammation of the wall of the vein, whereas in the latter there is little or no associated inflammatory process. For this reason, in phlebothrombosis the thrombus may not be firmly attached to the vessel wall and the danger of embolism is greater.

The significance of thrombophlebitis and phlebothrombosis to the orthopaedic surgeon lies in the fact that such a complication is not infrequently associated with conditions commonly observed in this field of endeavor. Thus, for example, patients with arthritis are particularly likely to develop thrombophlebitis, as are elderly patients with hip fractures. Its importance also lies in its immediate potential danger to the life of the patient, and its subsequent morbidity. For these reasons a consideration of the prophylaxis and therapeutics of this condition may be warranted.

No attempt will be made here to discuss in detail the etiology of phlebothrombosis and thrombophlebitis, as this has been reviewed previously. However, it is believed desirable to consider succinctly some of the factors which play significant rôles in the development of these conditions. These have previously been classified as: (1) predisposing and (2) precipitating. The most important of the former are constitutional diathesis, obesity, debility, systemic infection, pregnancy, trauma, operation, and circulatory disturbances. The precipitating factors are: (1) vascular changes, (2) blood changes, (3) infection, and (4) circulatory retardation.

By constitutional diathesis is meant a thrombo-embolic predisposition which is an inherited tendency, and is likely to occur in patients of the asthenic, adipose type. In a patient who has had a previous thrombosis, or who has a family history of this condition, it is highly desirable to employ prophylactic measures which will be discussed under therapy. Of the debilitating conditions, carcinoma is of particular importance, probably because of the destruction of tissue which produces changes in the blood, favoring thrombosis. Pregnancy is likely to be associated with thrombosis because of the increased intra-abdominal tension, re-

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sulting in pressure on the pelvic veins and vascular stasis in the lower extremity. Probably of all the factors, trauma is the most significant to the orthopaedic surgeon who is called upon so frequently to treat trauma of the osseous system with injury to the soft parts. The question has frequently been raised: Why is it that intravascular clotting does not occur more frequently following extensive injury to an extremity in which tissue damage, particularly to the soft parts, may be considerable? Certainly a trauma of equal severity elsewhere in the body would produce blood changes sufficient to be considered as precipitating factors in the production of thrombosis. These changes, as emphasized previously by the authors[5], are increased viscosity, hyperglobulinaemia, hyperproteinaemia, — that is, an increase in the albumin-globulin ratio — increased fibrinogen content, antitryptic power, peptidase, and calcium content, and a decreased carbon-dioxide-combining power of the plasma. In addition to these changes in the plasma, there are significant changes in the formed elements of the blood, which consist of an increase in the number of thrombocytes and an increase in their agglutination tendency. This is probably the result of the change in the albumin-globulin ratio of the plasma, tending to decrease the electrical charge of the platelets. The leukocytes are similarly increased, and also show an increased agglutination tendency. The erythrocytes, although decreased, show the same agglutination tendency, as exemplified by the rouleau formation.

Circulatory retardation has long been considered one of the most important precipitating factors. As previously emphasized[5,9], any condition which will interfere with the normal return circulation and predispose to venous stasis may act as a precipitating factor. Thus, posture, immobility, hypopnea, and increased abdominal tension may produce circulatory retardation.

In a patient with extensive trauma of an extremity associated with a fracture, in whom, after reduction has been done, immobilization is secured by means of plaster, it would seem that the conditions were ideal for the development of thrombosis, — namely, changes in the blood, which predispose to intravascular clotting, and circulatory retardation, favoring the production of a clot. For these reasons, it may at first appear difficult to explain why thromboses do not occur much more frequently in such instances. There are probably several reasons which might be given. Whereas trauma can and does occur in elderly individuals, most of the extensive injuries of the extremity occur in relatively young individuals whose vascular system is relatively unimpaired, and in whom vascular stasis is less likely to occur. It is a well-known fact, as has been previously emphasized by the authors[5,9], that intravascular clotting is more likely to occur in advancing age. Of even greater importance probably is the vasodilating effect of choline derived from the injured muscle in the extremity. This tends to offset the disadvantages of immobilization and tends to overcome vascular stasis. Of great significance also is the increased heat to the part, resulting from the retention

of the natural body heat by the plaster. Were it not for this last fact, probably many more venous thromboses would occur in such individuals. The authors [5,9] have previously directed attention to the significance of heat and consequent vasodilatation on the incidence of thrombophlebitis. Thus, for example, the incidence of thrombophlebitis is considerably lower in southern climates and during warmer months. The extremely low incidence of thrombophlebitis in this Clinic is due, in the authors' opinion, to the fact that heat tents which cover the lower portion of the body, including the lower extremities, are routinely applied postoperatively.

The clinical manifestations of venous intravascular clotting vary considerably according to the extent and site of involvement. Everything else being equal, the more proximal the location of the vein — that is, in the femoro-iliac area of the lower extremity — the more severe the clinical manifestations. Pain is almost invariably present. As venous clotting is most likely to occur in those areas in which there are the greatest number of tributaries, the popliteal vein, the veins of the calf, and the femoro-iliac veins are those most frequently involved. There is usually some fever, although the temperature elevation may not be high. A step-ladder type of temperature curve is quite common. Swelling of the extremity is an almost invariable accompaniment of deep-vein thrombosis, although it may be absent in involvement of the superficial veins. Here also the more proximal the vein involved, the greater are the extent and the degree of the swelling, — that is, the involvement is greatest in the femoro-iliac vein, where the typical phlegmasia alba dolens appears. The temperature of the involved extremity varies according to the site of involvement. In cases in which the superficial veins are involved, there is increased heat over and along the course of the involved vein, and there is usually redness, whereas in the individual with deep-vein involvement the extremity is frequently cold and white, as evidenced by the "alba" in "phlegmasia alba dolens". It is rather difficult to understand why, for so many years, physicians disregarded the apparent paradox that a patient with a definite inflammatory disease involving the venous system, as evidenced by marked pyrexia, should have an extremity which not only is not as warm as the rest of the body, but commonly is actually colder than a normal extremity. The whiteness of the extremity has been usually attributed to the stagnation of the lymph.

The diagnosis of intravascular clotting is not particularly difficult. The presence of predisposing and precipitating factors—such as antecedent trauma with tissue destruction, infection, circulatory retardation, and other factors stated above—are highly suggestive. If in addition to these factors there are such clinical manifestations as pain and tenderness over and along the course of an involved vein, associated with swelling of the involved extremity and fever, a diagnosis of thrombophlebitis is justified.

In venous thrombosis, as in other conditions, the best method of therapy is that of prophylaxis. Although one cannot control the degree of trauma in disease or in the accidental injuries, the surgeon can decrease the postoperative incidence of intravascular clotting by being as atraumatic in his operative technique and in his manipulations as is possible. In previous publications [7, 9, 10], the prophylactic therapy was discussed in detail, and the most important factors were outlined as: (1) hydration, (2) mobilization, (3) respiratory stimulation, (4) prevention of increased abdominal tension, and (5) application of heat. In this regard early post-operative mobilization of the extremities is highly desirable. In individuals in whom immobilization is necessary, the application of heat to the involved extremity is of importance. Obviously, in a patient whose extremity is immobilized in plaster, the retention of the body heat is efficacious in increasing the heat of an extremity and in producing vasodilatation. The avoidance of abdominal distention is of importance in reducing the likelihood of vascular retardation in the veins of the lower extremity. It is also important that the flow of venous blood to the heart should be favored by the use of deep-breathing exercises, as this increase in the intrathoracic negative pressure augments the return flow of blood.

Once thrombophlebitis has occurred, the most rational form of therapy is based upon an attempt to counteract vasospasm, and to produce maximum vasodilatation in the involved extremity. That vasospasm plays a prominent rôle in the development of the clinical manifestations of thrombophlebitis has been demonstrated by clinical and experimental observations [1, 3, 8]. On the basis of these observations it is believed that a vasomotor reflex is initiated in the thrombosed venous segment, causing widespread vasospasm of the vessels of the involved extremity. These vasoconstrictor impulses are transmitted by way of the sympathetic nerve fibers. This spasm in the arterioles is responsible in great measure for the decreased temperature and pallor of the involved extremity, which is so typical of a deep-vein thrombosis. It also explains the apparent paradox of a white, cold extremity in a patient who has a systemic pyrexia. The oedema, which previously has been attributed to the increased intravenous pressure resulting from obliteration of the large venous channel draining the extremity, cannot be explained on this basis, because by the prompt institution of adequate therapy the oedema will subside in a period of a few days, long before the intravascular clot has become recanalized. As previously emphasized by the authors [5, 7, 8, 9, 10], the oedema in cases of thrombophlebitis is not due primarily to the increase in the venous pressure, resulting from the plugging of the large venous channel of the extremity, but is due principally to a number of factors which are the result of the vasospastic influences arising in the thrombophlebitic segment. As a result of the marked arteriolar spasm, the blood flow through the capillaries is decreased. This causes a relative anoxia of the capillary endothelium which increases its permeabil-

ity and results in excessive exudation of intravascular fluid into the perivascular spaces. Although this explanation is adequate for the presence of increased perivascular fluid, it does not explain the persistence of the oedema. The vascular spasm, in venules as well as in arterioles, is responsible for its persistence. Because of spasm in these vessels and increased venous pressure, the pressure on the venule ends of the capillaries is increased, and this interferes with the absorption of the fluid in this area. Of particular importance in this regard, also, is the accumulation of proteins in the perivascular fluid, which further increases the oncotic pressure of tissue fluids, thus tending to hold and attract fluids into the tissue spaces. Normally, a good deal of the perivascular fluid gets back to the vascular system by way of the lymphatics. As has been shown by McMaster and Parsons [4, 11] and by Cressman and Blalock [2], movement of the lymph is dependent upon arteriolar pulsations. During the period of arteriolar spasm resulting from impulses originating in the thrombophlebitic segment, stasis of lymph occurs because the "pump", which is responsible for its movement, is not functioning normally.

Accordingly, the treatment of thrombophlebitis consists in producing vasodilatation of the involved extremity, and this can be done best by novocain block of the lumbar sympathetic ganglia, which successfully interrupts the vasoconstrictor impulses arising in the thrombophlebitic segment. In this way the vascularity in the capillary bed is increased; the relative anoxia of the capillary endothelium is prevented; and the normal permeability of the capillary endothelium is reestablished, which prevents the continuation of the excessive exudation of intravascular fluid into the perivascular spaces. Of equal importance also is the effect of the return of arteriolar pulsation on the movement of lymph. As arteriolar pulsation is the most important factor in the movement of lymph, the reestablishment of these normal pulsations will result in the removal of the excessive perivascular fluid and its return to the vascular system. This further decreases the protein content of the tissue fluid, which, in turn, diminishes its oncotic pressure, thus preventing the accumulation of perivascular fluids. Because of the relief of the spasm on the venule side of the capillary, absorption of the perivascular fluid into the venous end of the capillary is favored. In this way the rapid subsidence of oedema might be anticipated, a fact which has been established clinically.

The technique of the novocain block of the sympathetic ganglia is extremely simple, and has been adequately described in previous publications [6, 7, 8]. Briefly, it is as follows: For the lower extremities, lumbar sympathetic block is performed on the affected side, with the patient lying in the lateral recumbent position. The cutaneous sites of puncture are determined by taking a point approximately two to two and a half finger-breadths lateral to, and on a horizontal level with, the spinous processes of the first lumbar vertebra. Each needle is inserted verti-

cally until the transverse process of the vertebra is reached. The direction of the needle is then changed slightly, passing either above or below the transverse process, and the needle is introduced for an additional two to two and a half finger-breadths so that its point lies near the anterolateral surface of the body of the vertebra in the retroperitoneal space where the sympathetic chains lie. Five cubic centimeters of 1-per-cent. procaine-hydrochloride solution is injected through each needle, care being taken to determine previously that the needle is not in a vessel. In cases with involvement of the upper extremity, the anterior approach, which is a modification of the Leriche approach worked out by one of the authors (M.D.), is preferred. A point one centimeter medial to the mid-portion of the clavicle is chosen and an intracutaneous wheal of novocain is made into the skin immediately over the upper border of the clavicle. A fine lumbar puncture needle is introduced on a horizontal level with the clavicle and directed posteriorly and medially at a forty-five degree angle with the mid-line. The point of the needle, after being introduced for a distance of from six to seven centimeters, impinges against the anterolateral surface of the body of the seventh cervical vertebra or at the junction between the seventh cervical and first thoracic vertebrae, where the stellate ganglion lies. After ascertaining by aspiration that the needle is not in a vessel, ten cubic centimeters of 1-per-cent. novocain is introduced. A satisfactory injection is determined by the presence of Horner's syndrome, anhydrosis, and an increase in warmth in the extremity on the injected side. Sympathetic ganglion block is done daily until the patient is fever-free, because it is believed that, as long as the fever persits, vasospastic impulses can originate in the thrombophlebitic segment.

Forty-one cases of venous intravascular clotting have been treated in this way.* One of the most dramatic results of the therapy is the prompt relief of pain as soon as the procaine block has been completed. Within twenty to thirty minutes after the block, a patient who has previously had considerable pain is completely relieved. Of the forty-one patients, thirty-five (85.4 per cent.) were permanently relieved by the first block, and six (14.6 per cent.) required a second block to relieve them permanently of their pain. There is a rapid subsidence of fever, the temperature dropping 1 to 3 degrees within twelve hours. Of the forty-one patients, twenty-five (61 per cent.) were fever-free in forty-eight hours or less, nine (22 per cent.) were fever-free in from three to five days, five (12.2 per cent.) were fever-free in from seven to eight days, and only two had fever persisting longer than eight days. Of the forty-one patients, only forty had oedema, because one occurred in a patient who had had a previous amputation. The prompt relief of oedema is as dramatic as the subsidence of the fever. Of the forty patients with oedema, twenty (50 per cent.) had a normal-sized extremity within four

*Since this article was written, seventy-one cases have been treated by this method. An analysis of these results has been published.[11]"

days or less after the first block. In twelve (30 per cent.) the oedema subsided in from five to eight days, in six (15 per cent.) in from nine to ten days, and in two the oedema lasted as long as the eleventh or twelfth day. These figures, and the duration of the patient's stay in the hospital, are particularly significant when one considers that all of these patients had typical cases of phlegmasia alba dolens in which one would expect a long convalescence, a persistence of pyrexia for weeks, oedema for weeks or months or possibly for the rest of their lives, and the probability of the development of other postphlebitic sequelae. Not only are the discomforting symptoms and dangers of the condition obviated, but the prompt institution of adequate therapy in this condition is of great economic importance, as illustrated by the duration of the hospital stay in thirty-nine of the forty-one patients who were observed. Two of the patients were seen at home, so that they cannot be included in the hospital series. Twenty-six (66.7 per cent.) were discharged from the hospital on the fourth to the eighth day, nine (23 per cent.) from the tenth to the twelfth days, and only four (10.3 per cent.) remained in the hospital more than twelve days.

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A SIMPLE METHOD OF AMBULATORY TREATMENT OF FRACTURES OF THE CLAVICLE

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Greenstick fractures of the clavicle require very little attention. Wharton Hood's method is the simplest and gives satisfactory results.

In fractures of the clavicle with marked displacement, various methods of putting up the fracture have been described, each having its good points. Those that are simple are not effective, and those that are effective require a mechanic's help to construct a splint to suit the individual case. The principle of putting up fractures of the clavicle is well known, but maintenance of the fragments in the corrected position is difficult, due to respiratory movements and the difficulty of keeping the shoulders braced back without immobilizing the spine. Hawley tried to solve the problem by his T-shaped splint, but this requires constant attention and adjustment. Böhler's method of reducing a fracture of the clavicle is very simple, but it requires a mechanical appliance adjusted to fit each individual. In South India, working in a place where a mechanic's help is difficult to obtain, the author adopted the following simple technique, using plaster of Paris.

FIG. 1-A FIG. 1-B

Clinical photographs illustrating the method of using plaster bandages in correcting fractures of the clavicle.

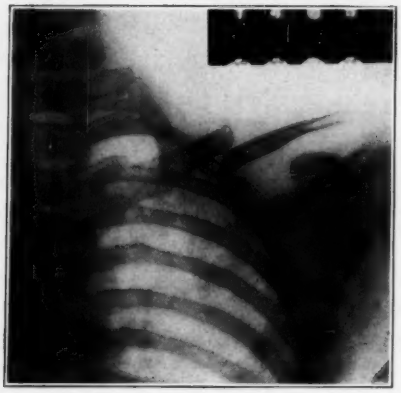

FIG. 2-A

Roentgenogram showing displacement of fracture of the clavicle.

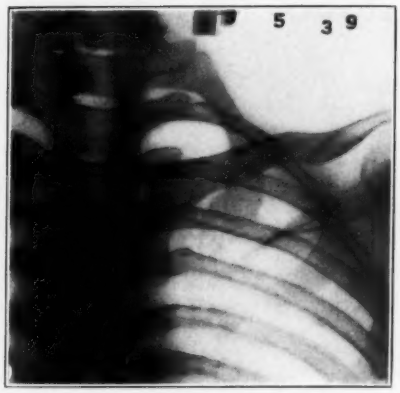

FIG. 2-B

Roentgenogram showing the result two years after reduction.

Two axillary roller pads of jute fiber covered with cotton, of the size required, are put under the armpits with the shoulders braced back by an assistant. Adhesive-plaster strips are applied to the area over the fracture of the clavicle, so as to give support and to prevent effusion. First, a pelvic support is made by plaster-of-Paris bandages rolled around the waist and molded over the crest of the ilium, and this support is covered with sponge rubber. Second, a padded plaster-of-Paris strip, four layers thick, four inches wide, and long enough to cover the front of the chest below the neck, is applied and molded over the front of the shoulders. A similar padded strip, four layers thick, four inches wide, and of the required length, is applied on the back and molded over the dorsum of the shoulders. (See Figures 1-A and 1-B.) Third, a plaster-of-Paris strip is made and rolled into a smooth rod, flat at the ends; this is fixed to the plaster-of-Paris strip on the back above and to the pelvic support below. Fourth, a flat, thick, smooth strip of plaster of Paris is molded to the injured side of the chest, the axillary pad, and the pelvic support. When this sets, it acts as an axillary crutch, lifting up the shoulder and maintaining it in that position. A roller plaster-of-Paris bandage is then passed around the axillary pads and the front and back of the chest over the strips in a figure of eight, and molded gently without causing undue pressure. Similarly, the lower end of the rod is firmly fixed to the pelvic support by a roller plaster-of-Paris bandage. When the plaster of Paris sets, the shoulders are automatically braced back and held in that position by the rod and strips in front and back of the shoulders, preventing bending or sagging; the axillary crutch supports the shoulder in the corrected position. This is a very simple and efficient method of reducing fractures of the clavicle by plaster-of-Paris splints and is very useful in tropical countries.

Plaster jackets in the ambulatory treatment of fractures of the clavicle, as described by Young, have been tried with success in two cases

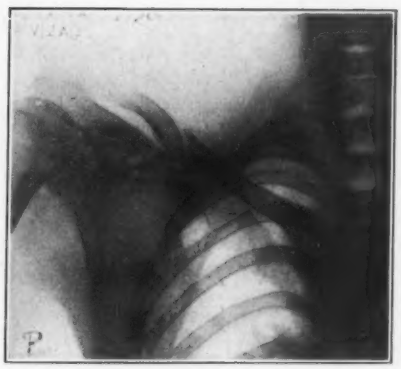

FIG. 3-A

Roentgenogram showing displacement of the fracture of the clavicle.

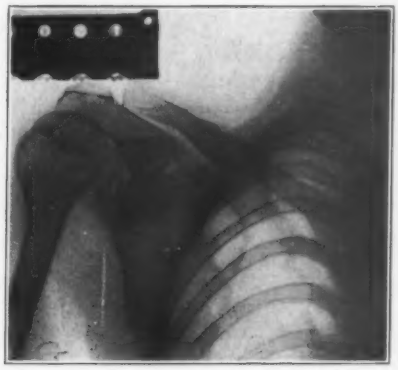

FIG. 3-B

Roentgenogram showing union of the fragments two years after the accident.

where a cosmetic result was desired. The principle is very good, but in tropical countries a plaster jacket causes great discomfort to the patient. The method just described has been modified by using a T-shaped splint with a posterior strip and axillary support (Figs. 4-A and 4-B). This method is quicker, and the results have been very encouraging.

The principle of the clavicle splint of Böhler has also been employed by the author. The axillary crutch is made by molding soft jute fibers into a pad covered with layers of plaster-of-Paris bandage; the portion of the splint which comes in contact with the side of the chest is made smoother

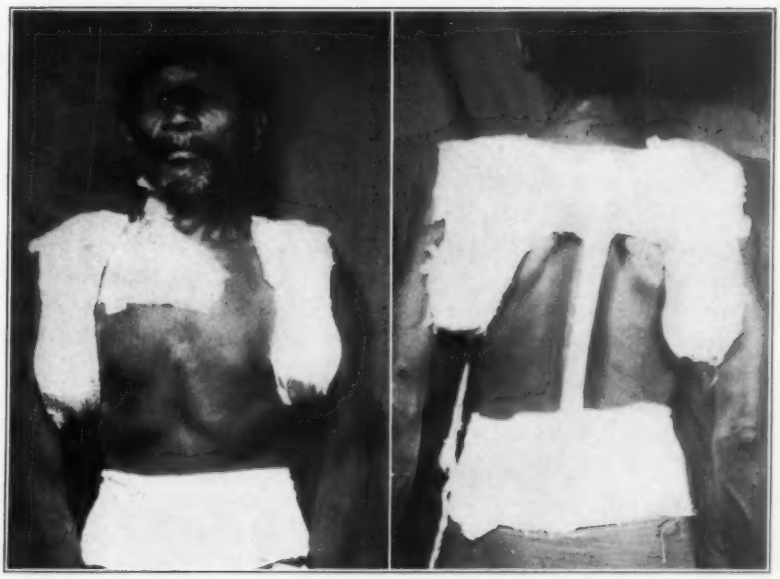

FIG. 4-A FIG. 4-B

Modified method of application of plaster-of-Paris splint for fracture of clavicle.

by using not more than two or three layers of plaster-of-Paris bandage and by inserting a layer of lint of the same size with the rough side next to the plaster of Paris when the plaster is still wet, so that the fluffy side is next to the skin. On the outer side, the pad is made a little thicker to strengthen it and to prevent it from cracking. The top of the pad is made smooth and round, and over it a sponge-rubber pad is fixed. The lower end of the pad is flattened, as it has to be fixed to the pelvic support made of plaster-of-Paris bandage. This method of application of plaster of Paris has given very satisfactory results. It is useful in treating older people whose shoulders should be kept free for movement. Usually strips of adhesive plaster are stuck on the area over the two fracture ends to give support and to prevent further effusion.

These methods are described to show how plaster of Paris can be put to a useful purpose for manufacturing splints when a mechanic's help is difficult to obtain.

The author wishes to express his gratitude to Dr. P. Kesavaswamy, roentgenologist, for the roentgenograms included in this paper.

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ACROMIOCLAVICULAR DISLOCATION

A New Operative Treatment *

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The majority of patients with dislocations and subluxations of the acromioclavicular joint recover with conservative treatment. In only a small percentage of the cases, which may be termed chronic, is there permanent impairment through pain and loss of function. The operation to be described is for the chronic type of lesion.

The function of the clavicle, other than for the attachment and origin of certain muscles, is purely one of a strut or buttress to hold the tip of the shoulder out from the body. It does not have any weight-bearing function. Excellent function of the upper extremity is consistent with an absence of the clavicle. This is seen in congenital deformities, or after the entire bone has been removed later in life, and in other cases in which the continuity of the clavicle has been disturbed, as in non-union of fractures, in complete dislocation at the acromioclavicular joint, and in partial excision of the bone. This point is illustrated by two patients seen by the writer: One was a nurse, in whom the entire clavicle was excised, and one was a man in whom the distal end of the bone had lost all contact with the acromion as a result of dislocation. In both cases there was complete and full function of the shoulder, without pain. The acromioclavicular articulation is a simple type of arthrodial joint without any special features. Within its capsule is found, not infrequently, a meniscus or articular disc, usually occupying the upper part of the joint. A superior and an inferior ligament strengthen the capsule. The clavicle, pivoting at the sternal end, is maintained in relation to the scapula by the coracoclavicular ligament, which has an anterior portion (trapezoid ligament) and a posterior portion (conoid ligament) to limit rotation of the clavicle.

Watkins,[1] in his study of acromioclavicular lesions, observed that, when the point of the shoulder is depressed, the clavicle comes to rest upon the first rib, and at the same time occurs a forward rotation of the clavicle about its sternal end as a center. If the force persists, either the clavicle fractures or the coracoclavicular ligament ruptures with an associated luxation of the acromioclavicular joint. It was upon these findings that he based his operation for the repair of the chronically dislocated acromioclavicular joint. The essential factor of the operation is the repair of the coracoclavicular ligament by means of a silk ligature passed around the clavicle and the coracoid process of the scapula. Practically all subsequent operations have been only modifications of Watkins' operation, the silk being replaced by fascial strips or other material. The

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FIG. 1

Case 1. G. A. Photograph showing function at end of three weeks following operation.

repair of the ligaments of the acromioclavicular joint has been a minor feature in these operations.

Watkins' operation was a decided improvement over those in which the acromioclavicular joint alone was attached by wires or other types of sutures. However, his operation was not only an extensive one, but, in the hands of many surgeons, failed to give a satisfactory result, the convalescence being long and the end result including pain and some impairment of motion.

Based upon the premise that a stable shoulder with full function and with absence of pain is consistent with a loss of continuity in the shaft of the clavicle, or even with a loss of a portion of the bone, the following operation was planned and executed. The report may be premature, as only four patients have been operated upon, all of whom have had what might be termed subluxation or partial dislocation of the joint, but the results were so satisfactory in every respect that the operation is presented so that its true value may be determined by other surgeons. In all the patients the period of disability was short. One patient returned to work at the end of two weeks. There has been no permanent deformity from an upward riding of the remaining portion of the clavicle, and the scar is not disfiguring.

FIG. 2-A

Case 2. C. F. Roentgenogram showing amount of bone removed from the end of the clavicle.

The operation was not done on any patient with complete and permanent dislocation. If there should be a persistent upward riding of the bone, this could be remedied by a fascial suture between the clavicle and the coronoid process. No excision of the sternal end of the clavicle has been done for a painful dislocation at the sternoclavicular joint, although this may be a rational procedure.

The operation is simple. A small, curved incision is made over the acromioclavicular joint and a skin flap thrown inward to expose the distal end of the clavicle. With a curved, blunt dissector, the end of the clavicle is freed from all surrounding soft tissue; and, with a sharp bone-cutting instrument, the distal end of the clavicle is cut and removed, together with any meniscus or joint disc that may be found in the joint. The cartilage on the acromion is not disturbed. The soft tissues are then drawn between the cut end of the clavicle and the acromion with catgut sutures, so as to cover the raw surface of the clavicle. No attempt is made to repair the ligaments about the joint. The skin flap is sutured with silk and the arm is held to the side of the body by a Velpeau bandage. This simple fixation is maintained for one week, and then active use of the arm is encouraged. Return to work should be possible within three to four weeks.

FIG. 2-B

Case 2. C. F. Photograph showing function at the end of six weeks following operation.

CASE 1. G. A., a woman, aged sixty-two, fell and injured her left shoulder four years before she was seen by the writer. Since that time she had had pain and limitation of motion. At the time of examination, the acromioclavicular joint was very tender and the distal end of the clavicle was slightly displaced upward. Abduction of the arm was limited to 90 degrees. Upon exploration of the joint, some proliferation on both the acromion and the clavicle at the joint line was found. The distal three-fourths of an inch was excised and the soft tissues were drawn across the cut end of the clavicle. The arm was carried in a sling for a period of two weeks. At the end of the third week, the patient resumed her household duties with almost complete abduction of the arm (Fig. 1). All symptoms of pain had disappeared.

CASE 2. C. F., a man, aged thirty, injured his left shoulder by a fall. The diagnosis of acromioclavicular dislocation was confirmed by roentgenograms. The shoulder was strapped for three weeks, but limitation of motion and pain persisted. The patient was operated upon eight weeks after the accident, at which time the distal inch of the clavicle was removed (Fig. 2-A). The patient returned to his work in a shoe store at the end of three weeks. Two months after the operation he was doing work of a heavy type, collecting cans of milk along a country route. The end results were full function of the shoulder and absence of pain (Fig. 2-B).

FIG. 3-A

Case 3. R. G. Photograph showing function at the end of four weeks following operation.

FIG. 3-B

Case 3. R. G. Photograph showing postoperative scar.

CASE 3. R. G., a man, aged twenty-five, injured his right shoulder playing football. The diagnosis of dislocation of the acromioclavicular joint was confirmed by roentgenograms. The shoulder was strapped for six weeks without relief of the symptoms. An operation was performed six weeks after the accident, at which time the distal inch of the clavicle was removed. The patient returned to work on a delivery truck at the end of two weeks. At the end of four weeks he was free of symptoms, and had complete function of the shoulder (Figs. 3-A and 3-B).

CASE 4. L. R., a man, aged thirty, had his left shoulder injured by the fall of a heavy hammer. He had no difficulty for two days, at which time the shoulder became painful, and motion was limited to about 50 per cent. Roentgenographic examination showed a slight displacement in the acromioclavicular articulation. The area over the joint became swollen and red, with evidence of an acute inflammatory condition. The patient was treated conservatively for two months without relief of pain, although the inflammatory condition had subsided. Two months following the accident the distal half-inch of the clavicle was removed. The patient made an uneventful recovery without symptoms, and had full function five weeks after the operation.

The roentgenogram shows the amount of the clavicle removed. The photographs show the range of motion in the shoulder after operation in three of the patients operated upon. Three of the patients were men, all of whom have returned to hard work and are free of symptoms. One was an elderly lady, whose joint showed proliferated arthritic changes, the lesion being of several years' duration. This patient also had a complete return of function in the shoulder without pain.

1. WATKINS, J. T.: An Operation for the Relief of Acromio-Clavicular Luxations. J. Bone and Joint Surg. VII, 790, Oct. 1925.

NOTE: Since this paper has been in the Editor's hands, the paper by Fraser B. Gurd on "The Treatment of Complete Dislocation of the Outer End of the Clavicle. An Hitherto Undescribed Operation" has been published in *Annals of Surgery* (Volume CXIII, page 1094, June 1941). This article by Dr. Mumford was therefore prepared without any knowledge of Dr. Gurd's work.—*Editor.*

ONE-PIECE ANGLE NAIL FOR TROCHANTERIC FRACTURES

BY EUGENE L. JEWETT, M.D., ORLANDO, FLORIDA

During the past two years the author has used a Smith-Petersen nail in combination with a flanged plate for five patients with pertrochanteric and intertrochanteric fractures of the femur. The histories of these five patients follow, with illustrations of four.

CASE 1. A woman, seventy-seven years old, sustained an intertrochanteric fracture of the left hip with a detached and displaced lesser trochanter. Figure 1-A shows the fracture a few hours after trauma. This patient was operated upon, and a Smith-Petersen nail and flanged plate were used. The lesser trochanter was anchored to the shaft by means of a long screw. The fragment could not be brought back absolutely to its original site, but the position was improved by the fixation, and it united to the shaft in a very satisfactory manner. Seven and one-half months after operation the woman walked with practically normal motion of the hip joint and only a little limp. Fifteen months after the operation (Fig. 1-B) she was getting about and doing things with no limp or pain. She says that this leg feels stronger than the uninjured one, and she can walk up and down stairs quite satisfactorily.

CASE 2. A woman, seventy-one years old, sustained an intertrochanteric fracture with partial separation of the lesser trochanteric region. Figure 2-A shows the fracture immediately after the accident. She was operated upon, and a Smith-Petersen nail,

FIG. 1-A

Case 1. December 28, 1939, preoperative roentgenogram.

combined with a flanged plate, was used. Fourteen months after trauma she had absolutely no complaints or disability referable to her injured leg (Fig. 2-B).

CASE 3. Ten years before she was seen by the author, this sixty-year-old woman had received a clinical and roentgenographic diagnosis of a probable malignancy with a resulting pathological fracture of the femur. Figure 3-A, taken ten years after fracture, shows the bone rarefied through disuse, marked coxa vara from contracture of the soft tissues between the ilium and the proximal fragment, and an ununited fracture. Figure 3-B shows the long screw and flanged plate in place. The bone was so decalcified that there was danger a Smith-Petersen nail would split it or pull loose too easily; therefore, a long screw was used instead. Eighteen months postoperatively she had a perfectly solid union, with very good painless use of the leg. She has two inches of shortening, which is compensated for by a raised shoe. No attempt was made to correct the contracture of the gluteal and other supratrochanteric soft structures, as a ten-year interval results in too much contracture to be relieved except by a great deal of surgery, which was not indicated in this patient.

FIG. 1-B

Case 1. March 13, 1941, one year and three months following operation.

CASE 4. A woman, seventy-five years old, had an intertrochanteric fracture with quite a bit of comminution around the fracture site. She was operated upon a few hours after trauma, and a Smith-Petersen nail and flanged plate were used. Figure 4-A shows the immediately preopera-

FIG. 2-A

Case 2. January 15, 1940, preoperative roentgenogram.

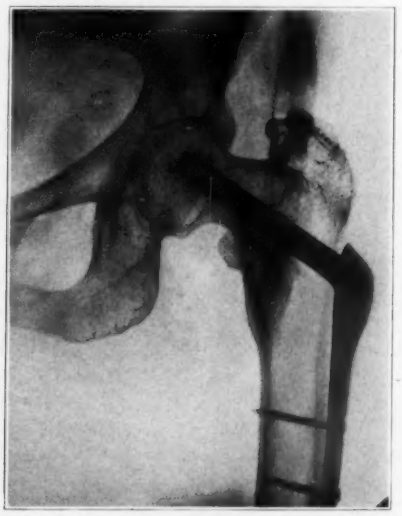

FIG. 2-B

Case 2. March 20, 1941, one year and two months following operation.

FIG. 3-A

Case 3. October 5, 1939, preoperative roentgenogram.

FIG. 3-B

Case 3. November 15, 1940, thirteen months following operation.

tive condition. Figure 4-B shows the roentgenographic result four months after trauma, at which time she was getting about fairly well with almost complete weight-bearing. Twelve months postoperatively (Fig. 4-C) she was walking about with practically no limp, no disability, and no pain whatsoever, except slight twinges during damp or cold spells.

CASE 5. A seventy-six-year-old woman sustained a trochanteric fracture with separation of the lesser trochanter. The Smith-Petersen nail and Hawley bone plate were used. The lesser trochanter was anchored by means of a screw. Three weeks after the operation the patient was up and about with crutches, and was rapidly obtaining excellent painless motion of that joint. Latest reports from her reveal that she is walking with a solid limb without the use of crutches or a cane, and with only slight limitation of motion and a little pain on certain movements. To all intents and purposes, she has a good result, especially since she is now about seventy-eight years old.

These patients were all operated upon under fifty or sixty milligrams of avertin per kilogram of body weight. In five of the cases, either gas-oxygen or ethylene supplementary anaesthesia was used, and in one case local infiltrated novocain was employed. The author does not use barbiturates or opiates preoperatively with avertin. Of course, atropine is indicated with any inhalation anaesthesia. The trauma necessary to operating on these elderly people is reduced to the lowest minimum, and a thorough medical check-up is undertaken in each case. Forced carbohydrate feeding for a couple of days before operation is strongly advocated, and any noticeable anaemia should be corrected either by medication or blood transfusion.

There was no postoperative cast applied, and no retentive apparatus of any type used, except occasionally sandbags placed along the limb for a day or two. The patient was put in Fowler's position as soon as possible, was turned from side to side at least twice a day, and was encouraged to take deep-breathing exercises and move about as much as possible. She was allowed out of bed when the sutures were out (on the ninth day), and encouraged to walk with crutches after two or three weeks, if such

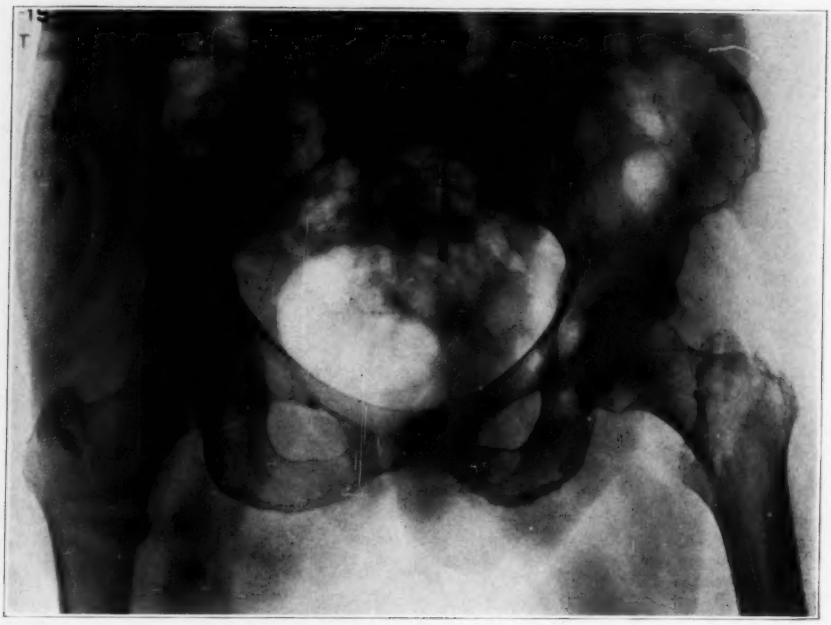

FIG. 4-A

Case 4. March 15, 1940, preoperative roentgenogram.

FIG. 4-B

Case 4. July 15, 1940, four months following operation.

FIG. 4-C

Case 4. March 14, 1941, one year following operation.

FIG. 5
One-piece hip angle nail.

was deemed safe. Full weight-bearing was allowed only when roentgenograms showed that there was absolutely solid union.

These patients have all done well, though it was felt that there were several unsatisfactory features about the procedure. First, there was no way that rotation of the flange on the Smith-Petersen nail could be prevented except by the friction between the rim of the nail, the socket of the flange, and the head of the screw. Were the screw to become the least bit loose there would be practically nothing to prevent rotation of the flange on the pin. Second, the screws in the flange were all in the same line, and there was not enough force there to prevent slight rotation or movement of the femur on the flange. Third, excessive metal protruded above the bone where the flange capped the Smith-Petersen pin. This feature has been somewhat eliminated in the much lighter and thinner flange manufactured by another company, but this apparatus still retains the other undesirable features outlined above. In one patient the author had a great deal of difficulty in screwing the flange to the nail because the Smith-Petersen pin was not driven in at quite the correct angle. It had to be withdrawn and redriven, so that the coaptation screw could be put in with the flange lying along the bone and still capping the Smith-Petersen pin at the correct angle.

With the idea of correcting the above features the author devised the one-piece flanged nail, which is merely a one-piece combination of the Smith-Petersen nail and a Hawley-type bone plate, but which greatly facilitates the technique of operation. This one-piece combination has been used in two cases with, so far, excellent results. However, these cases have been of such short duration that they are not being reported at present.

Figure 5 depicts fairly clearly the construction of the nail which may be made of vitallium or stainless steel. The flange is curved, so as to fit the surface of the femur, and permit the screws to slant toward each other when they enter the bone. This leads to much firmer anchorage than if they were parallel, and is especially true when the screws transfix both cortices of the bone, as they should always do. It may be that firm

FIG. 6

One-piece hip angle nail with short flange.

enough fixation would be accomplished without the use of the under flange, which fits into a slot in the bone. Without this angled feature, of course, it would be much easier to insert and attach the apparatus, but whether or not this would give enough anchorage would have to be determined by trial. The author believes that the Hawley angle feature insures greater stability, which in these fractures is desirable, but if there is any difficulty in marking a long enough groove in the femoral shaft to accommodate the under arm of the flange, this flange can be greatly shortened and still give enough stability to obtain the desired immobilization (Fig. 6).*

In using this nail there is nothing out of the ordinary to be recommended. The operator may use any method for driving in the nail. By the author's technique, the fracture is reduced by traction and manipulation, confirmed by roentgenograms, and then the patient is operated upon. Small Steinmann wire pins are used as guides, with a roentgenographic check. The nail is then threaded over the correctly placed pin and driven in. The slot for the under arm of the T-flange is easily made with a bone saw, although it can be fashioned by means of drill holes and a very thin-bladed osteotome. In the latter instance, however, care must be taken not to fracture the bone. The nail must be driven in with the flange plate kept parallel with the femoral shaft. It would not make a great deal of difference whether, as is desirable in such fractures, the Smith-Petersen nail were directly in the center of the neck of the femur throughout its course or not. The average angle made by the neck and the shaft is 120 degrees, and with the separate flanged-nail unit there are several different angles made, so as to apply to necks of different angles. However, by keeping the flanged arm of this single-unit flanged nail parallel with the shaft, the nail can be driven in, even though it does not go directly down the center of the neck in each case. In these trochanteric fractures, the pin is merely a stabilizing arm and does not necessarily bridge the fracture site, except where the fracture line is proximal to the lower intertrochanteric ridge. Where it is desired to keep a considerable stock of these nails on hand at all times, it would

* Since this paper was written the shorter-flanged one-piece nail has been used on three additional patients and has been found to be much better than the long, full-length ones. The groove can be made with just a few drill holes and an osteotome, and does not necessitate the use of a bone saw.

be a simple matter to have them made up with different angles.

Another problem which has puzzled the author has been what to do with the detached loose lesser trochanteric fragment. The general practice has been to ignore this condition, and the author can find no mention in the literature of any attempts to anchor it. We are all familiar with the pain associated with movement of the hip joint, where such a fracture is present. The iliopsoas muscle, which inserts into the lesser trochanter, and the pectineus, which along with the iliacus inserts a little below the lesser trochanter, tend to displace this fragment upward during movement or contraction. Pain ordinarily persists for several weeks, during which time not only is hip motion painful, but the lesser trochanter may be pulled quite a distance proximally from its original site. Many times an excessive callus weld is thrown out because of this migration and more or less constant irritation, even though the fragment seldom fails to unite. The excessive weld of callus often impairs the painless full range of motion of the joint. With this problem in mind the author began to anchor this fragment to the femur with a screw (Fig. 7), and found it was a comparatively easy thing to accomplish during any surgical fixation for the neck or pertrochanteric region. The fingers can be placed around anterior to the bone, and the lesser trochanter can be easily pulled into place without any danger to the overlying blood vessels or nerves. In some cases the entire procedure can be done under full subperiosteal exposure. With this fragment anchored in place, the patient can move about and sit up in bed with very little pain a day or two after the operation. This is a sound procedure and certainly does not add much trauma to any operation on the upper end of the femur or neck.

FIG. 7

Showing (a) the one-piece hip angle nail in place, and (b) the separate fixation of the lesser trochanteric fragment.

CASE 6. A seventy-eight-year-old woman suffered an intertrochanteric fracture of the left hip with complete detachment of the lesser trochanter. Figure 7, taken six weeks following the operation, shows this patient with the author's one-piece flanged nail in place. The lesser trochanter had first been fixed to the shaft by an extra screw. She has had a remarkedly easy time of it so far. She has been up in a chair since one week after the operation, and has been able to move her leg fairly easily since the second day. After this roentgenogram (Fig. 7) was taken, she was allowed to begin gradual weight-bearing, with the help of nurses, of course. She absolutely refuses to use crutches. She has almost complete painless range of motion of the hip with only a little tenderness about the fracture site, and still some atrophy of the leg.

It is too early to report the end result of this case; it is presented merely to show the one-piece flanged nail in use, and the separate fixation of the lesser trochanteric fragment.

SUMMARY

The use of both the Smith-Petersen nail and the Hawley bone plate has given good results in five patients. The difficulties encountered in their combined use have been greatly lessened by welding them together into a one-piece flanged nail. Shortening the flange has still further simplified the use of the one-piece flanged nail.

The advantages of anchoring the "floating" lesser trochanter to its bed by screw fixation are definite and warrant the slight added operative time and trauma.

BONE TUBERCULOSIS IN NORTHERN NEWFOUNDLAND

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From the International Grenfell Association Hospital, St. Anthony

Tuberculosis is the most common cause of death among the people of Newfoundland and southern Labrador. In this Hospital of 100 beds there were 8,778 admissions in the fifteen years from January 1923 to December 1937, 10.11 per cent. of which were for tuberculosis. (See Table I.) Of the total admissions, 3.05 per cent. were for bone tuberculosis.

The people treated are chiefly fishermen of British ancestry. The climate is cold and damp with much foggy weather. The standard of living is low among the fishermen. For six to eight months of the year many of the people live entirely on white bread and tea, with perhaps a small amount of butter and a few potatoes. Beriberi is still very common in many sections. This survey includes three Labrador Eskimos.

It is hoped that, in the future, studies can be made as to the relative prevalence of the bovine or human bacilli in the cases of bone tuberculosis. It can only be said that pulmonary tuberculosis is very common in Newfoundland, and that a large percentage of cattle are thought to be infected with bovine tuberculosis.

The care of these patients has been chiefly under the direction of the senior author, although several visiting surgeons, including Dr. J. T. Rugh of Philadelphia and Dr. Arthur Krida of New York, treated some of them during a summer visit of a month or more at St. Anthony.

During the fifteen years of this study, 175 patients were admitted to the Hospital 268 times with bone tuberculosis. Last year an attempt was made to reexamine the patients within reach, and a form letter was sent to the remainder. Follow-up examinations or letters made possible the securing of information from 157 of these patients, or 89.7 per cent. The average follow-up period was eight and nine-tenths years.

In analyzing the results of treatment, the patient's condition will be referred to as excellent, if he is able to do hard manual labor; as good, if he can do light work; as fair, if he uses a crutch or other type of support; and as poor, if he is bedridden. In the case of multiple bone lesions, the patient is classified only under the first joint for which he received treatment.

As has so often been emphasized, bone tuberculosis is not a specific disease of a particular part of the skeleton, but is a local manifestation which has had its source elsewhere, and which is frequently accompanied by tuberculosis of another organ. For this reason, the case summaries will be divided into two groups: those that have no other clinical evidence of tuberculosis, and those that have other tuberculous foci in the lungs, genito-urinary tract, peritoneum, other bones, or elsewhere. Any patient who has had a history of other tuberculous foci, even though apparently

TABLE I

ADMISSIONS FOR ALL FORMS OF TUBERCULOSIS FROM JANUARY 1, 1923 TO DECEMBER 31, 1937

Location of Lesion	No. of Cases	Percentage of Total Admissions *	Percentage of Admissions for Tuberculosis
Lungs	473	5.39	53.2
Bone	268	3.05	30.2
Peritoneum	38	0.43	4.3
Testicle	30	0.34	3.4
Lymph glands	24	0.27	2.7
Meninges	23	0.26	2.6
Kidney	16	0.18	1.8
Tubes and ovaries	6	0.07	0.7
Skin	5	0.06	0.6
Appendix	1		0.1
Intestines (unclassified as to type)	1		0.1
Sclera of eye	1	0.06	0.1
Breast	1		0.1
Mesentery	1		0.1
Total	888	10.11	100.0

* Total admissions for the period were 8,778.

healed at the present time, will be included in the second group. The authors feel, that while there may be no clinical evidence of activity in the former seat of disease, one can never be sure that an old smouldering tuberculous focus will not flare up and cause death from meningitis or pulmonary disease. This was strikingly exemplified recently in the case of a forty-six-year-old man, who had a tuberculous hip twenty-one years ago, and who died quite suddenly of tuberculous meningitis. He had led an active life with an ankylosed hip for many years. Only two months before his death he had a thorough examination, including a urinalysis, and roentgenograms of the chest, which showed no evidence of tuberculosis.

This Hospital has a limited staff, and, at times, limited facilities, so that complete work-ups and roentgenograms, particularly of the lungs and kidneys, were not done in all cases. However, great care has been taken in classifying the patients into the groups with and without tuberculous foci. History, physical examination, and sputum and urine examinations have been evaluated when roentgenograms were not available. Roentgenograms have confirmed all but three of the joint lesions; these patients were felt to present a clear clinical picture of bone tuberculosis.

TUBERCULOSIS OF THE SPINE

This series includes seventy-eight cases of tuberculosis of the spine, an incidence of 49.7 per cent. of the joints involved in the 157 patients followed. (See Table II.) The vertebra most frequently affected was

TABLE II

RELATIVE FREQUENCY OF JOINTS INVOLVED IN THE PATIENTS FOLLOWED

Location of Original Bone Lesion	Number of Cases	Percentage of Total Bone Tuberculosis
Spine	78	49.7
Hip	26	16.5
Knee	24	15.3
Foot and ankle	17	10.8
Shoulder	5	3.2
Elbow	3	1.9
Wrist	2	1.3
Sacro-iliac	2	1.3
Total	157	100.0

the twelfth thoracic, with the fourth and fifth lumbar vertebrae close seconds. Those patients having involvement of the lower thoracic and lumbar regions showed the best response to treatment. Patients with upper thoracic and cervical lesions responded less favorably.

It has been the general policy to operate on all patients who are not too poor risks, as this Hospital is small and a rapid turn-over of patients is essential. The patients receiving non-operative therapy include those who were judged poor operative risks, those with sinuses or paralyses, and those refusing operation. The usual routine has been operation after a varying period of from one month to two years' observation. By far the greater number were operated upon within one or two months of admission. The Albee procedure was followed in all but two patients, in whom the Hibbs operation was performed. Before operation the patient had anterior and posterior plaster shells prepared, in which he was immobilized for three months postoperatively. The patient was then fitted with a brace which he was instructed to wear for a year at home.

Those in the non-operative group were treated by Bradford or Pyrford frames, casts, and braces. A few refused all treatment. The results are tabulated in Table IV. It may be seen that 82.4 per cent. of the patients with no other clinical focus of tuberculosis stand a chance of leading a useful life after operation, following as short a time as four months of hospitalization. If, however, they have or have had other foci of tuberculosis, operation has nothing to offer. In the small series of patients falling within this group, those having operation did no better than those treated conservatively, when it is realized that the patients who were operated upon, were considered the better risks. The mortality in all patients with tuberculosis of the spine was 35.9 per cent. The mortality in patients who were operated upon and who had no other foci, was 8.8 per cent. Three patients with tuberculosis of the spine and no other foci, who have since died, have not been included in our mortality figures.

TABLE III

SUMMARY OF CASES SHOWING PERCENTAGE OF MORTALITY FOLLOWING OPERATIVE AND NON-OPERATIVE TREATMENT

Location of Original Bone Lesion	Number of Patients	Operative Group		Non-Operative Group	
		No Other Tuberculous Foci Present	Other Tuberculous Foci Present	No Other Tuberculous Foci Present	Other Tuberculous Foci Present
Entire series					
Patients	157	54	32	45	26
Deaths	45	5	19	8	13
Mortality per cent.	28.7	9.3	59.4	17.7	50.0
Spine					
Patients	78	34	22	13	9
Deaths	28	3	14	4	7
Mortality per cent.	35.9	8.8	63.7	30.8	77.8
Hip					
Patients	26	6	5	9	6
Deaths	7	0	2	2	3
Mortality per cent.	26.9	0	40.0	22.2	50.0
Knee					
Patients	24	7	3	10	4
Deaths	4	0	2	1	1
Mortality per cent.	16.7	0	66.7	10.0	25.0
Foot and ankle					
Patients	17	6	2	5	4
Deaths	3	1	1	0	1
Mortality per cent.	17.6	16.7	50.0	0	25.0
Upper extremities					
Patients	10	1	0	7	2
Deaths	2	1	0	1	0
Mortality per cent.	20.0	100.0	0	14.3	0
Sacro-iliac					
Patients	2	0	0	1	1
Deaths	1	0	0	0	1
Mortality per cent.	50.0	0	0	0	100.0

They were in excellent health and lived normal lives seven, eleven, and twelve years after operation, and died from causes totally unrelated to their tuberculous disease,—one from drowning, one from lobar pneumonia, and one in childbirth. The mortality in those receiving non-operative treatment was 30.8 per cent. These figures compare favorably with others reported in the literature.

This series includes seven patients with paralyses, six, or 85.7 per cent., of whom had no other foci. Four were treated conservatively with one death from pulmonary tuberculosis. One was operated upon while paralyzed, one during recovery while still spastic, and one after recovery of motion. Of these, two had excellent results, and the third, good.

Three patients had a second Albee operation because of extension of the

TABLE IV

RESULTS FOR PATIENTS WITH TUBERCULOSIS OF THE SPINE

Result	No Other Tuberculous Foci Present				Other Known Tuberculous Foci			
	Operative		Non-Operative		Operative		Non-Operative	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Excellent	20	58.8	5	38.4	4	18.2	1	11.1
Good	8	23.6	2	15.4	2	9.1	0	0.0
Fair	2	5.9	1	7.7	1	4.5	1	11.1
Poor	1	2.9	1	7.7	1	4.5	0	0.0
Dead	3	8.8	4	30.8	14	63.7	7	77.8
Total	34	100.0	13	100.0	22	100.0	9	100.0

disease. Two of these, with other tuberculous foci, died. In three patients infection developed postoperatively, in two of whom the grafts sloughed. The first reports his condition as excellent, the other two as good, though one still has a sinus with intermittent drainage (six years postoperatively).

In the recent symposium on spinal tuberculosis,[3] attention was drawn to persistent abscesses and their relation to lack of clinical improvement. In this series, 55 per cent. of the patients showed clinically or by roentgenograms the presence of abscesses. The mortality in this group was 23 per cent., and in the group without abscesses and without other tuberculous foci, 15 per cent. Although this would tend to show a poor prognosis in this group, the records and roentgenographic reports are not complete enough to draw further conclusions.

Four patients with draining sinuses received operative treatment, one with excellent, two with good, and one with fair result. One of these still has a draining sinus, six years postoperatively. Two patients treated conservatively are both living, one with a good and the other with a fair result. In the group with other tuberculous foci and sinuses, there were five patients, only one of whom was treated operatively. All have since died. In two patients sinuses developed after leaving the Hospital. One of these patients was operated upon.

Ten children under twelve years of age have been treated, all of whom had no other tuberculous foci. Six were treated operatively and four conservatively, with one death in each group. The death after operative treatment was from lobar pneumonia twelve years later. The child had previously been in perfect health. The other death was from tuberculous pneumonia. The youngest child treated operatively was aged three. The result was excellent three years later. This series is too small to draw conclusions concerning the preferability of operative or conservative therapy in children.

TUBERCULOSIS OF THE SACRO-ILIAC JOINT

Of the two patients with tuberculosis of this joint, one had other foci and died, the other was treated conservatively with a cast for seven months and then with a brace. Now, six years later, he is in excellent health.

TUBERCULOSIS OF THE HIP

The hip was found to be the second most common location of bone tuberculosis, occurring twenty-six times in this series. Thirteen operations were performed on eleven patients. An extra-articular fusion was performed eleven times,—six patients had tibial grafts, and five, a bone flap from the outer table of the ilium to the trochanter. The Chandler operation was performed twice. Two of the patients who had had a fusion with a graft from the tibia needed a secondary operation, because of non-union of one end of the graft. There were two deaths in this group, both occurring several years after operation and in patients with other tuberculous foci. All other patients who were operated upon had excellent or good results. All patients who received operative treatment report stiff joints. In the group who were not operated upon, six report stiff joints, three report motion in their hips, and one failed to report.

One of the patients operated upon had sinuses. Five patients with sinuses were treated conservatively. One patient in each group developed sinuses following discharge from the Hospital. In the three patients with sinuses and no other foci, the results were favorable.

Of the six children receiving treatment three, aged eight, ten, and eleven, had a stabilization operation, with two excellent results and one good. Another child was treated conservatively in a spica for three years, then discharged, returning ten years later for operation. Now, six years after operation, she has a good ankylosis, is able to work, but is still annoyed by a persistent draining sinus. Two children received conservative treatment with one excellent result and one fair. The latter has persistent pain in his hip and is anticipating an operation shortly.

TUBERCULOSIS OF THE KNEE

There were twenty-four cases of tuberculosis of the knee, making this the third most frequent site of involvement. Ten patients received operative treatment. In nine a resection of the knee joint, as advocated by Henderson, was performed. One had an amputation because of the extent of involvement of the knee joint. Another had an amputation six months after operation, because of non-union and increased activity of the disease. Of the seven patients who had a resection, but no other tuberculous foci, three report their results as excellent, two as good, and one as poor. From correspondence with the seventh patient, it would seem that renal tuberculosis had developed. Those patients with uncomplicated tuberculosis of the knee, treated by resection, averaged only four and one-half months' hospitalization.

Among the patients not operated upon, there were ten without,

and four with, other tuberculous foci, with a single death in each group. Of the former, three report excellent results, two good, and one poor. Taking the group as a whole, 54 per cent. are now in excellent health, which makes this the most favorable joint for treatment.

Three patients with sinuses were treated conservatively with good results.

Five children were treated conservatively with no deaths. Three report their condition as excellent with stiff knees; one as good with partial restriction of movement; and one as fair with no ankylosis. Roentgenograms in all these cases reveal joint involvement. While this group is very small, the results are quite different from those of McKeever, who reports no satisfactory results with conservative treatment in forty-six out of forty-seven children. However, these results with conservative treatment still fall short of McKeever's results following operation.

TUBERCULOSIS OF THE ANKLE AND FOOT

Seventeen patients were treated in this group. Eight received operations and nine were treated non-operatively. Six patients had a Syme amputation of the leg, and two had an arthrodesis of the ankle. The authors have had excellent results with the Syme operation, which was first described by Sir James Syme of Edinburgh in 1843, and used by him as a substitute for higher amputation of the leg in tuberculosis involving the ankle joint. The Syme operation was gradually forgotten, but after the World War I attention was again called to this excellent operation by Wilson. All patients with no other tuberculous foci, who had a Syme amputation, are living. These cases were in adults who are carrying on very strenuous lives,—fishing, and dog driving. Three operations were done over fifteen years ago. Four patients with sinuses were operated upon (Syme amputation), and three were treated conservatively. The sinuses have all healed and patients report their condition as excellent.

Five children with this condition were treated conservatively with casts or heliotherapy and all are well.

TUBERCULOSIS OF THE UPPER EXTREMITIES

There were five cases of tuberculosis of the shoulder, three of the elbow, and two of the wrist. Of these ten cases, eight were uncomplicated, and two patients had other tuberculous foci. Involvement of the shoulder seemed to occur more frequently in cases of multiple bone foci than of the other joints. Tuberculosis of the hip later developed in one patient, tuberculosis of both elbows in another, and tuberculosis of the spine and shoulder in a third, who was listed under tuberculosis of the hip. All of this group, except one, were treated conservatively with braces, collar slings, casts, etc. This one patient had an amputation of the lower forearm for tuberculosis of the wrist. There were two deaths in this group, neither of whom had other tuberculous foci. The patient who had the amputation died thirteen years later of pulmonary tuberculosis.

COMMENTS

From these results the futility of operating upon patients with other tuberculous foci is evident. The authors feel that all patients with bone tuberculosis should have roentgenograms made of the chest, and, where symptoms or urine suggest renal tuberculosis, a thorough urological examination. It would seem that in a general Hospital, such as this, conservative treatment, especially in cases of spinal and hip tuberculosis, cannot be carried out properly, as much of the care of these patients is delegated to general duty nurses and hospital aides, who have neither the background nor the time required for proper handling of orthopaedic cases. As has been previously mentioned, the time of hospitalization is another factor that has to be considered. If a patient can receive operative treatment and be out of the hospital in three to six months, rather than after several years, such treatment would seem preferable from the viewpoints of both the hospital and the patient.

In tuberculosis of the hip, the best results have been obtained by an arthrodesis employing the bone flap from the ilium. In this small series none of the patients needed a second operation for non-union. The chances of infection are less with one incision than with two. This operation has been equally satisfactory in adults and children.

In tuberculosis of the knee, the Henderson type of resection has been found to give very satisfactory results in adults. The authors have had no experience with operative treatment in children.

In tuberculosis of the ankle in adults, the Syme operation is an ideal form of treatment, and may be classified as a conservative operation, eliminating as it does the focus of the disease, and giving an excellent functional result. In children conservative treatment is indicated.

In all twenty-seven children, twelve years and under, there was one death related to the patient's tuberculosis. It is a significant fact that at the time of treatment only one of these children had clinical evidence of other forms of tuberculous disease. This would seem the most likely reason for the good prognosis in children.

The authors have not found that the presence of tuberculous sinuses has in any way altered the patients' prognoses.

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THE SHELF OPERATION FOR CONGENITAL DISLOCATION OF THE HIP

A New Technique for the Old Irreducible Dislocation *

BY LEO S. LUCAS, M.D., PORTLAND, OREGON

In the old dislocated hip with defective acetabulum, the shelf operation provides the best method of obtaining stability. This is especially true when the hip can be reduced into the primary socket. Great difficulty has been experienced in the construction of a suitable shelf in the high dislocations, when the acetabulum is obliterated and the upward dislocation is so great that restoration of the head of the femur to the primary socket cannot be obtained. It is the purpose of this paper to present an operative technique for this type of dislocation, which the writer has found meets the requirements for producing a stable, workable hip joint.

The important factors to be considered in the production of such a shelf are:

1. A heavy, wide ledge of bone which fully covers, and extends well in front of and behind, the head of the femur.
2. A downward sloping ledge of bone which retains its blood supply.
3. A suitable bed which will allow the head of the femur to mold a deep, stable socket, and which will function on the order of the original acetabulum.

When a patient is considered a proper subject for the shelf operation, skeletal traction is applied for a period of from two to three weeks in order to relax the ligaments and muscles, and to gain as much length as possible.

OPERATIVE TECHNIQUE

First Stage

The patient is placed on the operating table face down and the surgical field is prepared over the posterior ilium opposite the side of the dislocation. A curved incision is made conforming to the crest of the ilium. A large wedge of bone is removed, beginning well up at the crest, and cut deep to the inner table of bone, measuring about two and one-half inches in length and two inches in width (Fig. 1). This can be trimmed to suit when ready for placement beneath the roof in the second stage of the operation. The incision is closed and dressings are applied.

Second Stage

The patient is turned on his back, and the hip is prepared. The leg and thigh are draped so that the leg can be moved freely without the danger of contaminating the operative field.

* Read at the Meeting of the North Pacific Orthopaedic Society, Portland, Oregon, November 23, 1940.

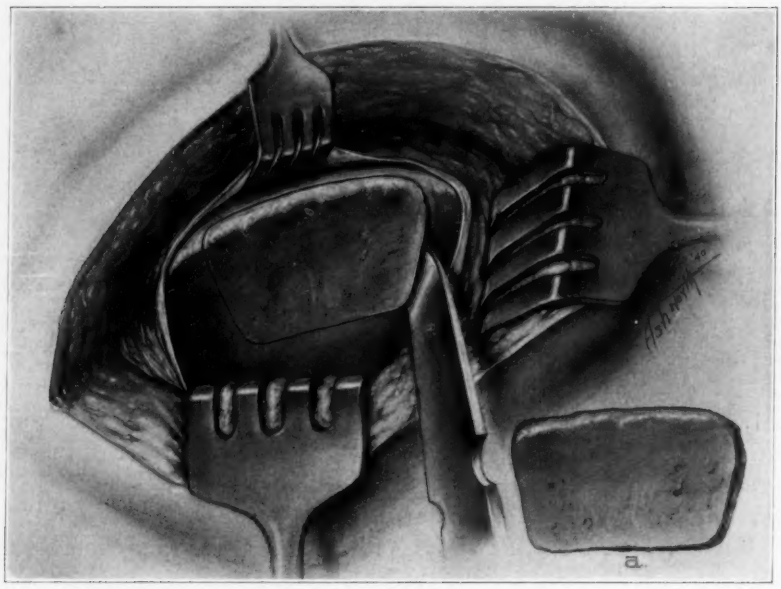

FIG. 1

Supporting wedge is taken from the posterior ilium in the first stage of the operation.

A Smith-Petersen incision is made beginning well back on the ilium. The gluteal muscles and periosteum are freed downward. The rectus femoris and sartorius attachments are pushed upward and retracted well out of the field. The superior attachment of the capsule is displaced downward with the periosteal elevator to the rim of the primary acetabulum. The capsule is trimmed of its excess bulk (Fig. 2). The leg and thigh are flexed to 90 degrees and adducted, in order to displace the head downward and backward. This provides a good view of the operative field above the capsular attachment. With a sharp osteotome a bone flap is outlined (Fig. 3) and cut deep to the inner table; the lower cut is parallel to the upper edge of the old acetabulum and about two and one-half inches in diameter, and the vertical cuts extend upward for a distance of from three to three and one-half inches. With a curved chisel the flap is then freed at the lower border from the inner table of bone, and the chisel is driven upward until the flap is free to the upper extremity of the vertical cuts. The flap is teased outward and the wedge from the posterior ilium is trimmed to suit and inserted beneath the flap with the thicker side directed downward (Fig. 4). Then by lowering the leg and thigh the head is carefully eased beneath the flap (Fig. 5). The incision is closed and a hip-spica cast is applied with the leg slightly abducted. The original cast remains on for a period of twelve weeks. A short spica is then applied, and weight-bearing is permitted for one month in the cast.

Nine patients have been operated upon in this manner over a period of two years. Eight are now walking without support and have strong,

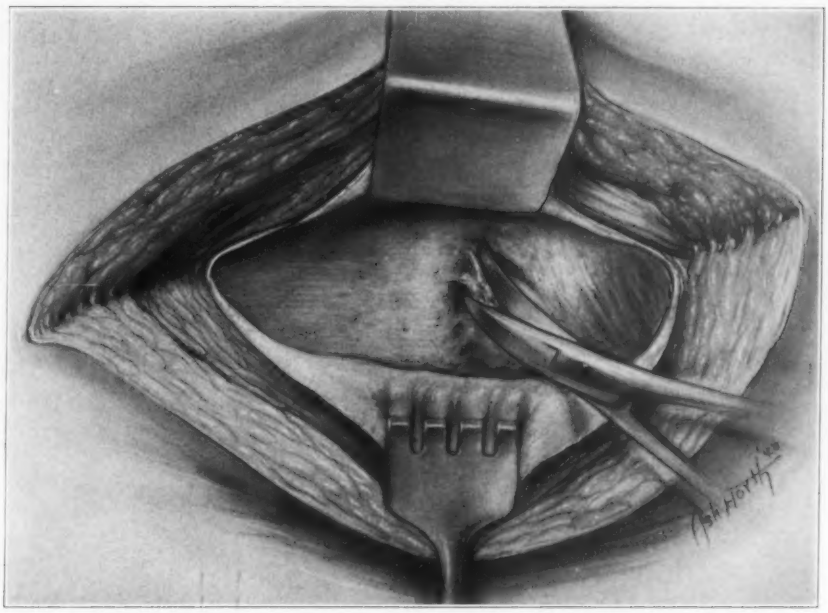

FIG. 2

Following the exposure of the capsule, it is trimmed of its excess bulk.

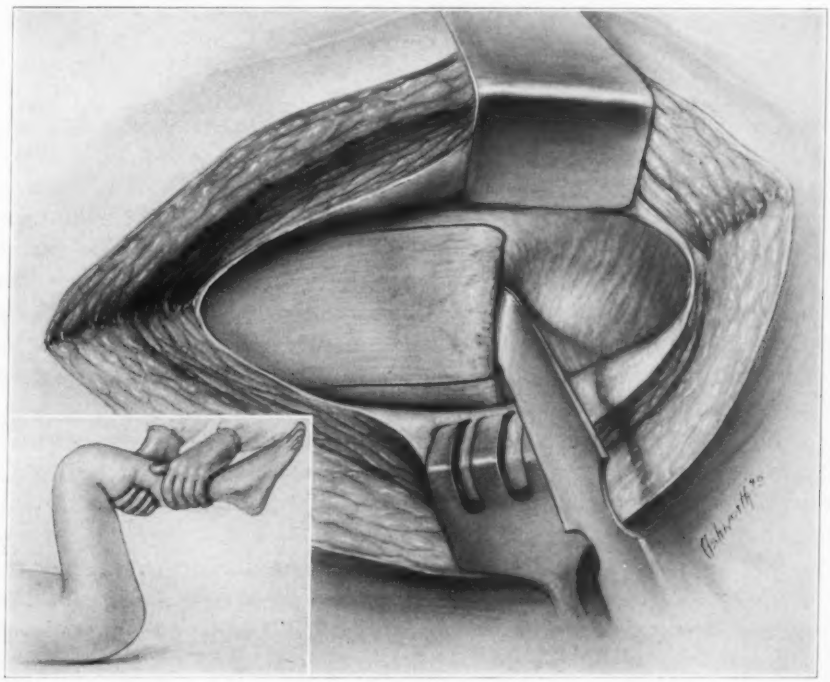

FIG. 3

Primary outline of the bone flap cut deep to the inner table of bone. The thigh and leg are flexed and adducted.

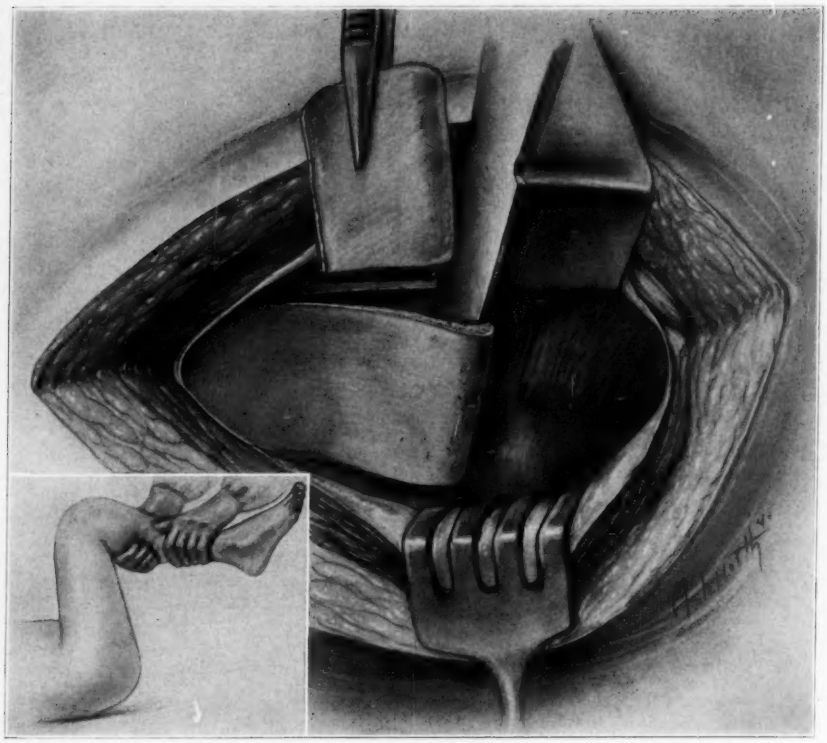

FIG. 4

The bone flap is gently elevated and the bone wedge inserted beneath it. Note the depressed head of the femur, which is due to flexion and adduction of the thigh and leg.

stable hip joints. The Trendelenburg test was absent in these eight cases. In one patient (Case 5) the bone flap was absorbed. This child was allowed up with full weight-bearing in eight weeks. This, the author feels, was too early, and possibly was a contributory factor in the failure. In this patient the Trendelenburg test is still present. In two patients the flap was partly broken at its base during the operation, because of a too rapid elevation, but it remained vital.

Deep sockets with a heavy supporting ledge of bone have been obtained as evidenced by the roentgenograms (Cases 1, 2, 3, and 4). Serviceable hip excursion is produced early by active physiotherapy and use of the limb.

The supporting wedge should be taken from the posterior ilium near the crest and deep to the inner table of bone, since a thicker graft can be obtained here. It also obviates weakening the ilium in front above the shelf, and lessens the trauma to the primary surgical field. Projection of the shelf laterally to the level of the trochanter is not undesirable as excess bone rounds off and is absorbed and there is no undue interference with abduction.

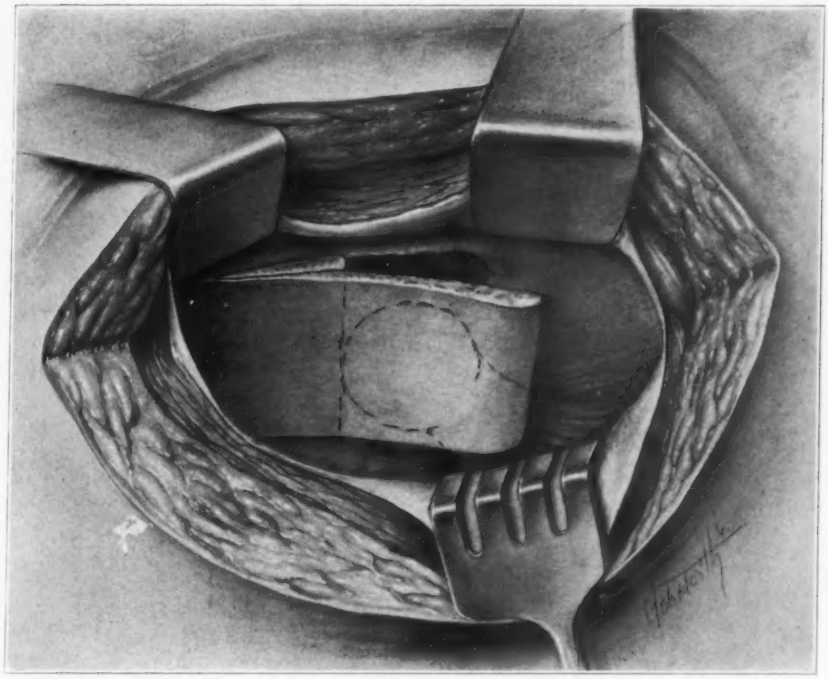

FIG. 5

The head of the femur is shown beneath the flap with the supporting wedge in place above the head.

This operation provides an articulation which corresponds more closely to the primary socket, and the load on the hip muscles is decreased as compared to that of the shelves which depend entirely on bone wedges extending outward from the surface of the ilium.

The hip should be brought down, as far as possible, before the operation by skeletal traction, in order to stretch the ligamentous and muscular tissues, and to gain length. Traction during the operation is not necessary, as flexion of the thigh and leg, in conjunction with deep anaesthesia, affords good mobility of the head and permits it to be easily displaced from the operative field.

It is important that the head with its capsule be well freed, so that the head can be brought forward above the site of the primary acetabulum. The capsule in no case should be cut through in order to release the head. Kidner [1] has shown that the capsule may be attached to the ilium for an inch or more above the acetabulum. It can be separated from the ilium with the periosteal elevator down to the primary rim. A great deal of the thickened capsule should be trimmed away in order to do away with an excess of bulky tissue.

Many failures in other operations described are due to not placing the graft firmly against the head of the femur. If a gap is allowed to exist between the head and the prepared ledge, there may be an unstable,

weak joint and a continuance of the positive Trendelenburg. This in turn leads to the likelihood of redislocation of the head from beneath the shelf. If the shelf does not contact the head firmly, there is a greater tendency toward absorption of the shelf several months following the operation, because of increased excursion and constant forcible upward thrusts against the new bone.

The operation described provides a wide shelf that covers the head well, and extends far enough back so that, when the thigh is flexed, there is no possibility for the head to slip from beneath the roof. It conforms more to the actual depth of the old acetabulum and has an actual downward sloping roof which holds the head encased, so that redislocation is impossible; and above all it utilizes a flap of bone which has its original attachment, and consequently retains its blood supply and therefore is not absorbed.

FIG. 6-A

Case 1. February 24, 1939. Congenital dislocation of the hip in a boy, aged thirteen. The acetabulum is obliterated.

FIG. 6-B

Case 1. Roentgenogram taken March 18, 1939, shows the shelf the day following the operation. Note the length of the bone roof and the wedge above the head of the femur.

This procedure necessitates the preparation of two surgical fields with two incisions, but with an experienced surgical staff the operation can be performed quite rapidly, approximating the time required for other types of shelf operations, and the procedure does not produce any appreciable amount of shock.

CASE REPORTS

CASE 1. R. O., a male, aged thirteen, reported to the office on February 23, 1939, complaining of pain, following extensive use of the limb, and gradually increasing shortening. There was no history of previous treatment. Examination disclosed a marked limp, noticeable bulging of the gluteal fold, and the presence of the Trendelenburg sign. Measurement revealed shortening of three inches. Roentgenographic examination showed marked displacement of the head of the femur without any evidence of a secondary socket (Fig. 6-A). The primary acetabulum was entirely obliterated. The diagnosis of congenital dislocation of the hip was made. Skeletal traction was applied for two weeks; then a shelf operation was done (Fig. 6-B). After three months in the original

cast a short hip spica was used and full weight-bearing was allowed. Examination fifteen months following the operation disclosed three inches of shortening, a painless, stable hip, strong gluteal muscles, excellent hip excursion with abduction of about 20 degrees (Figs. 6-C and 6-D).

FIG. 6-C

Case 1. Roentgenogram taken May 19, 1941, shows the end result of the shelf operation two years and two months following the operation.

FIG. 6-D

Case 1. May 19, 1941. Hip movements are free. Note the range of abduction.

FIG. 7-A

Case 2. February 28, 1939. Congenital dislocation, defective acetabulum with marked upper displacement.

CASE 2. C. H., a male, aged ten, was seen in the office February 17, 1939. He had a congenital dislocation of the hip which had been treated by closed reduction when he was three years of age. Examination revealed a marked limp, the presence of the Trendelenburg sign, and three inches of shortening (Fig. 7-A). He complained of some pain on exertion. On February 20, 1939, skeletal traction was applied, and on March 7, 1939, a shelf operation was done. A spica cast was worn for three months, and a walking short spica for one month. On September 6, 1940, he had a painless, stable hip, one and one-half inches of shortening, flexion to 90 degrees, normal extension, and abduction to 25 degrees (Fig. 7-B).

CASE 3. C. T., a female, aged eight, had an unsuccessful closed reduction for a congenital dislocation of the hip on December 20, 1937. On March 12, 1939, she was admitted to the Shriners' Hospital for Crippled Children (Fig. 8-A) and traction was applied for two weeks. A shelf operation was performed on March 27, 1939. At present the patient walks with a scarcely perceptible limp, and has one-half inch of shortening, a stable hip, free range of motion, and no pain (Fig. 8-B).

FIG. 7-B

Case 2. Roentgenogram, May 16, 1941, shows end result two years and two months following the shelf operation. The hip is stable and the function is good.

CASE 4. L. P., a male, aged fourteen, had a bilateral congenital dislocation of the hip. An unsuccessful attempt at reduction of the hip was made on January 4, 1937.

FIG. 8-A

Case 3. Roentgenogram, March 10, 1939, shows congenital dislocation of the hip, defective acetabulum, and lateral upward luxation.

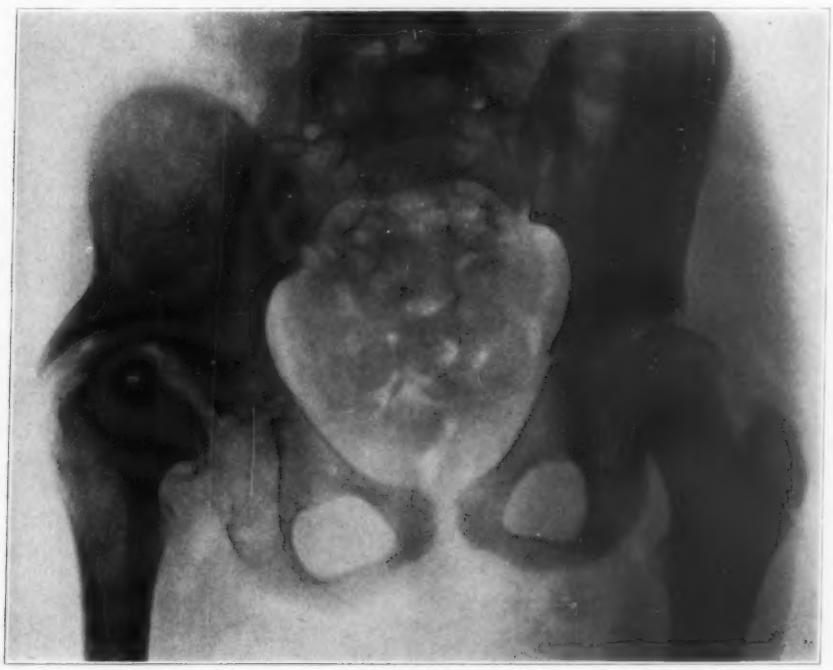

FIG. 8-B

Case 3. Roentgenogram, June 12, 1941, shows end result two years and three months following shelf operation. Excellent stability and function.

FIG. 9-A

Case 4. Roentgenogram, August 25, 1939, shows bilateral congenital dislocation of the hip, marked upward dislocation of the right hip, and defective acetabulum.

FIG. 9-B

Case 4. Roentgenogram, February 23, 1940, shows end result five months following shelf operation. There is free motion, and the stability and function are good.

A shelf operation of the left hip on March 24, 1937, resulted in stability and a fair range of motion. He was admitted to the Shriners' Hospital for Crippled Children on May 13, 1938, for treatment of the right hip, because of pain and instability. The conventional type of shelf operation was done. The shelf was later absorbed and recurrence of the luxation was noted in December 1938. On September 18, 1939, the new type of operation was performed, which resulted in a solid shelf and a clinically stable hip with a good range of motion (Figs. 9-A and 9-B).

CASE 5. M. P., a female, aged eight, was admitted to the Shriners' Hospital for Crippled Children on March 15, 1938, with a congenital dislocation of the left hip. Closed reduction was done March 23, 1938. She was readmitted, May 25, 1939, because of redislocation. The head of the femur was dislocated high above the acetabulum, and the socket was found to be very shallow and defective. A shelf operation was performed, June 14, 1939, and weight-bearing was permitted in two months. The shelf was found to be nearly completely absorbed on December 29, 1939. This is the only failure in the series of nine cases.

CASE 6. F. D., a female, aged fifteen, had been treated in the Shriners' Hospital for Crippled Children for anterior poliomyelitis since 1930. Most of the work had been confined to the extremities on which various stabilizing procedures had been done. The left hip was defective and was displaced upward and posteriorly. A shelf operation was performed, August 16, 1939. One year following the operation the muscle power had improved, motion was free in all directions, roentgenograms revealed a good shelf, and clinically the hip was stable.

CASE 7. C. T., a female, aged eight, had a congenital dislocation of the right hip, for which a closed reduction was done on December 20, 1937. Examination in August 1938, showed a redislocation with one and one-half inches of shortening. Because of the deficiency of the acetabular rim, a shelf operation was performed, March 27, 1939. The new socket formed slowly and some absorption of the shelf resulted, due to a partial break in the graft at its base at the time of operation. The final result was a stable hip, with free range of movement, one inch of shortening, and a scarcely perceptible limp.

CASE 8. E. Z., a female, aged nine, had a bilateral congenital dislocation of the hip. Closed reduction was performed, February 22, 1932. The left hip remained stable, but the right hip redislocated. A second closed reduction was done on the right hip, April 17, 1934, following which the hip gradually luxated again. The acetabulum was very shallow, and the acetabular rim defective. The girl was followed in the Out-Patient Clinic until June 1940. Because of two inches of shortening, marked limp, and pain, she was admitted for a shelf operation. When last seen, December 12, 1940, the hip was stable, the Trendelenburg sign was absent, there was one and one-quarter inches of shortening, and the hip excursion was fairly free.

CASE 9. D. R., a female, aged ten, was first seen in the Clinic of the Shriners' Hospital for Crippled Children on October 20, 1931, when a diagnosis of congenital dislocation of the right hip was made. Closed reduction was done on October 28, 1931, and when the patient was discharged the hip was in the socket; but in 1937 it was found to be redislocated. Because of limp, pain, and shortening, she was readmitted and operated upon on January 20, 1941. The patient has a stable hip, the Trendelenburg sign is absent, and the roentgenograms show that a good shelf has been formed.

SUMMARY

The operative technique described for the stabilization of the irreducible hip in older children and adults, provides a stable socket from which the hip cannot be dislocated, and utilizes a bone plastic flap that remains attached to the ilium and retains its blood supply.

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RETROLUNAR DISLOCATION OF THE CAPITATE WITH FRACTURE OR SUBLUXATION OF THE NAVICULAR BONE

BY EDWIN FRENCH CAVE, M.D., BOSTON, MASSACHUSETTS

From the Fracture Clinic of the Massachusetts General Hospital, Boston

Dislocation of the capitate bone, with fracture or subluxation of the navicular, has been third in frequency of occurrence in the series of carpal bone injuries at the Massachusetts General Hospital. It is, however, far outnumbered by fractures of the navicular bone, and dislocations of the lunate. All fractures and dislocations of the carpus represent about 2 per cent. of bone injuries in this Clinic.

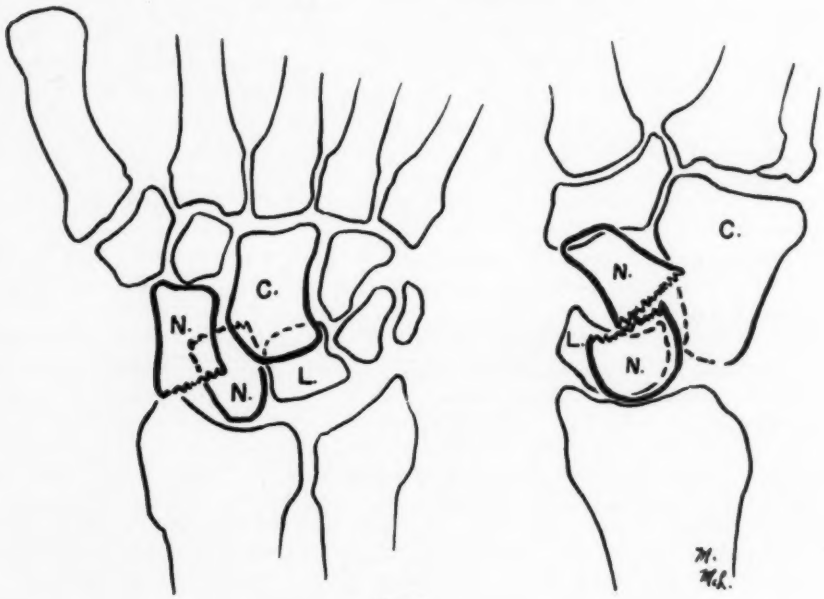

FIG. 1

Tracings of fracture of the navicular (*N*) and retrolunar dislocation of the capitate (*C*).

MECHANISM

Retrolunar dislocation of the capitate (os magnum), sometimes referred to as transcarpal dislocation, is produced by a blow which suddenly forces the hand into dorsiflexion. The commonest type of injury is a fall on the outstretched hand. The force may be transmitted through the third metacarpal, or may be received directly by the distal portion of the capitate. The dislocation of the capitate must be accompanied by a fracture of the navicular bone, or rotation luxation of this bone. Usually great force is required to bring about such an injury. When the injury occurs, the ligamentous structures between the lunate and the capitate are ruptured, and the blood supply is interrupted. The

lunate retains its normal relationship to the radius, or may be tilted slightly toward the palmar surface; the capitate is displaced dorsally to the lunate bone. At the same time, because of the shortening of the distance between the radius and the second row of the carpus, the navicular either must be fractured transversally (Fig. 1), or must rotate through its long axis (Fig. 2). If the navicular has been fractured, the distal portion of the bone moves dorsally and upward with the displaced capitate, while the proximal fragment continues to maintain its normal relationship to the radius. More frequently the navicular may be subluxated rather than fractured, and rarely is it completely dislocated.

DIAGNOSIS

As with all other carpal injuries, the diagnosis is based entirely upon the roentgenograms and thorough knowledge of the anatomical relationship of the carpus is required to interpret them. Standard exposures should be made (Fig. 3). The writer has frequently seen the diagnosis of retrolunar dislocation of the capitate confused with dislocation of the lunate bone, as occurred in the following case:

CASE 1. R. W. (No. 318839), aged twenty, male, was admitted January 20, 1932. Two months before, he had fallen on the dorsiflexed hand while playing football. He had had no treatment. Roentgenograms on admission showed what was interpreted as a dislocation of the lunate. The lunate bone was excised through an anterior incision. As original roentgenograms had indicated, however, the correct diagnosis was retrolunar dislocation of the capitate (Figs. 4-A, 4-B, and 4-C). One year later there was marked limitation of motion, particularly in palmar flexion, but no pain.

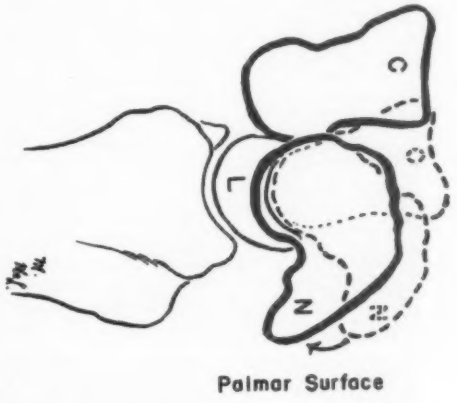

FIG. 2

The capitate (*C*) is displaced dorsally to the lunate (*L*) while the navicular (*N*) has rotated so that the tubercle or distal portion points toward the palm.

TREATMENT

The Treatment of Dorsal Dislocation of the Capitate and Rotation Luxation of the Navicular.

With this injury, immediate closed reduction by traction in hyperextension, then in extension, and finally in flexion is indicated. The earlier the manoeuvre is attempted after injury, the more likely it is to succeed. If it is delayed beyond a few days, open reduction may be necessary, and if many days or weeks have passed, even operation may fail. If closed reduction is successful, immobilization with an anterior splint for ten days is sufficient.

CASE 2. W. S. (No. 333357), aged thirty-seven, male, was admitted to the Emergency Ward November 12, 1933, with a retrolunar dislocation of the capitate, rotation luxation of the navicular, fracture of the head of the radius, and fracture of the ulnar styloid, following an automobile accident. Reduction had been attempted under ether anaesthesia, but had failed (Figs. 5-A and 5-B). On November 17, an incision was made over the dorsal aspect of the wrist. The capitate was found to be displaced backward on the lunate, and the navicular was rotated, so that it occupied partially the normal position of the capitate. The capitate was reduced to its normal relationship with the lunate and this brought the navicular into normal position. On November 25, the patient was discharged from the Hospital, wearing a plaster splint. All apparatus was discarded at the end of two weeks. One year later the patient was working at his old job. He had no pain; motions were three-quarters normal, and still improving. Roentgenograms show normal relationship of bones (Figs. 5-C and 5-D).

Treatment of Retrolunar Dislocation of the Capitate with Fracture of the Navicular.

When in addition to the dislocation of the capitate, there is a fracture of the navicular, such fracture may reduce spontaneously as the displaced

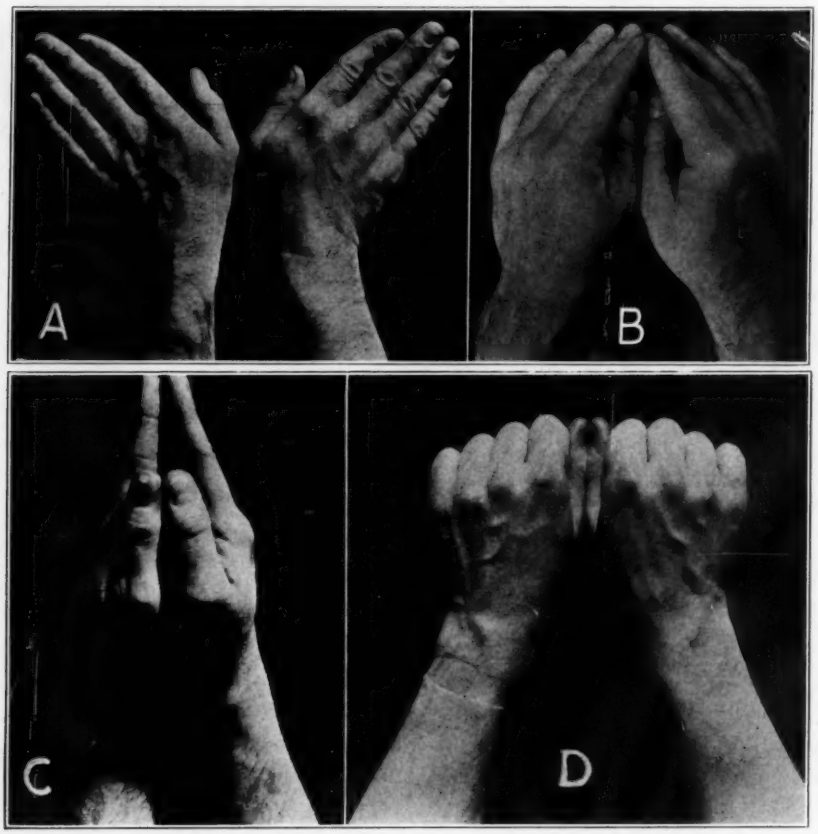

FIG. 3

Standard exposures for roentgenography of the carpus. (*A, B, and C reproduced by courtesy of J. B. Lippincott Company, and the American Medical Association.*)

FIG. 4-A

FIG. 4-B

Case 1. R. W. (No. 318839). Figs. 4-A and 4-B show a typical retrolunar dislocation of the capitate.

FIG. 4-C

Case 1. R. W. (No. 318839). End result of retrolunar dislocation of the capitate. Lunate has been removed; navicular has been displaced forward into the palm; capitate is articulating with the radius. (Open reduction of dislocated capitate with restoration of the navicular and lunate to normal position would have been treatment of choice.) (*Courtesy of J. B. Lippincott Company.*)

capitate is restored to its normal position; but if accurate reposition of the navicular fragment is not obtained, open operation should be done, and the fragments of the navicular realigned, and held with a dowel graft.

The following two cases illustrate this point: In the first case (McK.) the fractured navicular was treated with closed reduction of the dislocation, and later a dowel graft to the navicular. The second (B. C.) was

treated by closed reduction only. Note that union of the navicular was produced in the first case, and that non-union of this bone resulted in the second. Otherwise the cases are very similar.

CASE 3. McK. (No. 134433), aged seventeen, male, was admitted June 15, 1938, one-half hour after he fell from a moving truck, landing on the dorsiflexed left wrist. Roentgenograms revealed a retrolunar dislocation of the capitate, and fracture of the navicular, with dorsal and upward displacement of the distal fragment of the navicular (Fig. 6-A). Under general anaesthesia, fluoroscopic reduction of the dislocation of the capitate and fracture of the navicular was done. Postreduction roentgenograms showed unsatisfactory position of the navicular fragments (Fig. 6-B). On

FIG. 5-A

FIG. 5-B

Case 2. W. S. (No. 333357). Figs. 5-A and 5-B show in anteroposterior and lateral views a recent retrolunar dislocation of the capitate and rotation dislocation of the navicular.

FIG. 5-C

FIG. 5-D

Case 2. W. S. (No. 333357). Figs. 5-C and 5-D show result after open operation.

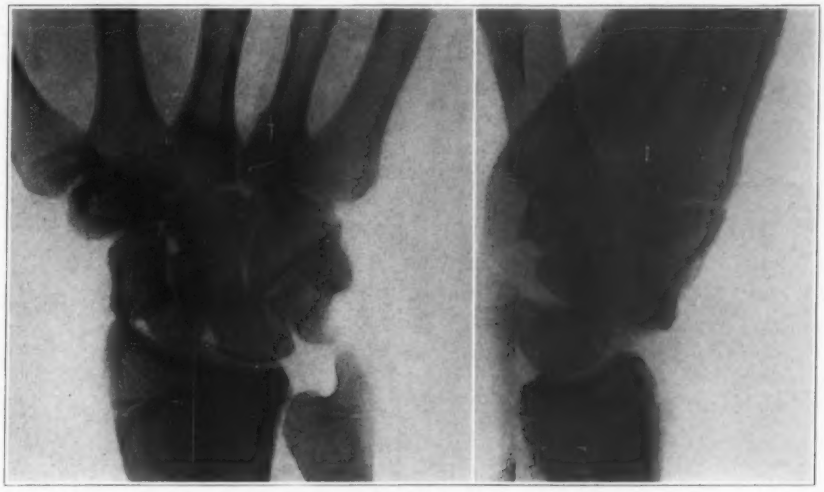

FIG. 6-A

Case 3. McK. (No. 134433). Anteroposterior view showing fracture of the navicular with displacement; and lateral view showing retrolunar dislocation of the capitate.

June 23, 1938, under general anaesthesia, a bone graft from the tibia was placed in the left navicular bone. After postoperative immobilization for four months, roentgenograms, taken October 31, 1938, showed bony union of the navicular with the graft in place. On March 6, 1940, patient was symptom free, and working at a printing press. There was a slight thickening over the dorsum of the navicular. There was dorsiflexion on the right of 45 degrees, left, 45 degrees; palmar flexion on the right of 25 degrees, left, 30 degrees; ulnar deviation on the right of 20 degrees, left, 10 degrees; radial deviation on the right of 20 degrees, left, 5 degrees; pronation on the right of 90 degrees, left, 90 degrees; supination on the right of 90 degrees, left, 90 degrees. Grip was equal on both sides. Roentgenograms showed complete bony union (Fig. 6-C).

FIG. 6-B

Case 3. McK. (No. 134433). Anteroposterior view showing incomplete reduction of the fractured navicular.

CASE 4. B. C. (No. 127846), aged eighteen, male, was admitted May 10, 1938. Five days before, the patient had fallen backward on the dorsiflexed left wrist. A splint was applied. Roentgenograms revealed retrolunar dislocation of the capitate; fracture of the cuneiform and navicular, with displacement (Figs. 7-A and 7-B). The distal fragment of the navicular was displaced dorsally and upward. Under general anaesthesia, fluoroscopic reduction of the dislocation and fracture was made. Postoperative immobilization was continued for four months, when roentgenograms showed satisfactory reduction of the dislocation, but non-union of the navicular fracture. On March 18, 1940, twenty-two months after injury, there was a slight thickening of the dorsum of

FIG. 6-C

Case 3. McK. (No. 134433). Anteroposterior and oblique views three months after operation, showing bony union of the navicular fracture with the graft in place.

the wrist. There was dorsiflexion on the right of 80 degrees, left, 70 degrees; palmar flexion on the right of 65 degrees, left, 10 degrees; ulnar deviation on the right of 20 degrees, left, 20 degrees; radial deviation on the right of 25 degrees, left, 15 degrees; pronation on the right of 90 degrees, left, 90 degrees; supination on the right of 90 degrees, left, 90 degrees. Grip was equal on both sides. This was a fairly good clinical result at this time, but, be-

FIG. 7-A

FIG. 7-B

Case 4. B. C. (No. 127846). Fig. 7-A: Lateral view showing retrolunar dislocation of the capitate.

Fig. 7-B: Anteroposterior view showing fracture of the navicular with displacement.

cause of non-union of the navicular, this bone is potentially a source of trouble, and will probably cause pain in the future. Operation and bone graft to the navicular was advised.

The graft operation must be done within a few days, otherwise one may find it impossible to realign satisfactorily the navicular fragments, even though the dislocated capitate may have been reduced. If it is necessary to reduce the capitate by open operation as well as to graft the navicular, two incisions—one a mid-dorsal, and the other a curved radial incision—should be employed (Figs. 8 and 9).

Postoperative fixation in plaster in this type of case should be carried out until union of the navicular is complete,—that is, usually from six to twelve weeks.

The Treatment of Old Retrolunar Dislocation of the Capitate, with or without Fracture of the Navicular Bone.

The neglected case probably cannot be satisfactorily treated by attempting to restore normal position of the carpal bones. If this fails, one must choose between (1) excision of the lunate and navicular bones and (2) wrist fusion. Excision of these two bones may result in improved motion, and less pain in the wrist, but will produce a weakened wrist, probably necessitating the use of external support for heavy work. Wrist fu-

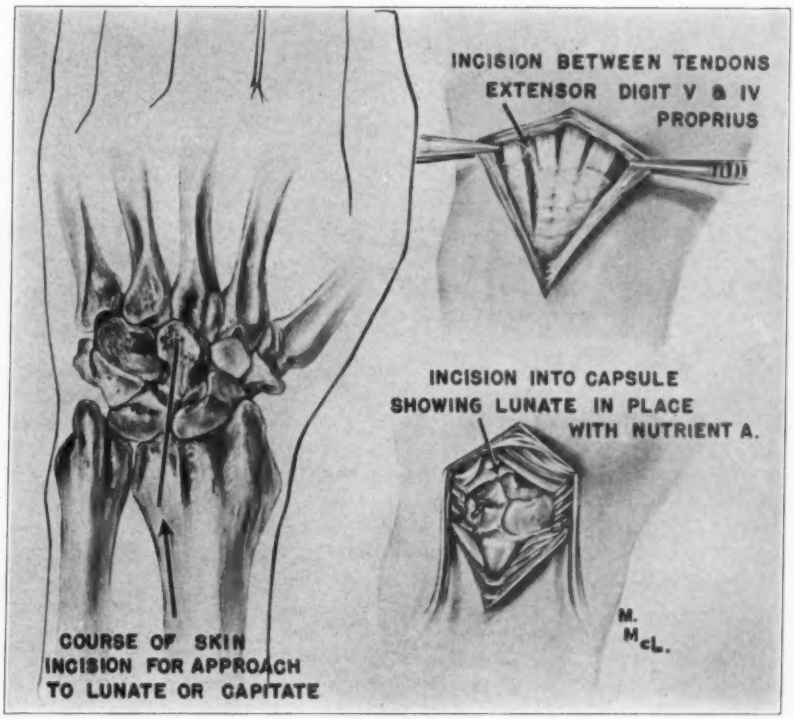

FIG. 8

Dorsal approach to carpus.

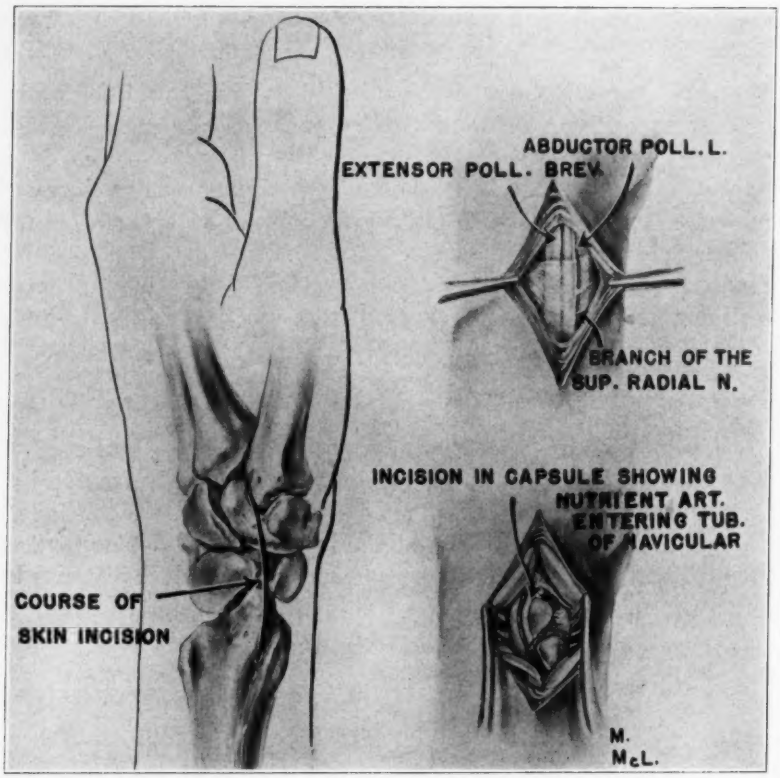
ABDUCTOR POLL. L.
EXTENSOR POLL. BREV.
BRANCH OF THE SUP. RADIAL N.
INCISION IN CAPSULE SHOWING NUTRIENT ART. ENTERING TUB. OF NAVICULAR
COURSE OF SKIN INCISION
M. McL.

FIG. 9

Radial approach to the navicular bone. (*Courtesy of the American Medical Association.*)

sion is the alternative to the excision operation; this will produce a strong wrist, and while motion in dorsiflexion and palmar flexion will be eliminated, pronation and supination can be maintained, if the fusion is carried out only between the radius and the carpus.

CASE 5. A. J. (No. 341976), aged thirty-one, male, was admitted to the Emergency Ward on September 21, 1934, with multiple contusions and abrasions of the arm and leg, fracture of the ulnar styloid, and chip fracture of the lesser trochanter, following a motorcycle accident. His left arm was put in a plaster splint. The patient continued to have trouble with his wrist, which was swollen, painful, and limited in motion. Two and a half months after injury, further roentgenograms revealed retrolunar dislocation of the capitate and fracture of the carpal navicular, with posterior displacement of the proximal fragment of the navicular (Fig. 10-A). A dorsal incision was made in the mid-line. It was impossible to reduce the fractured navicular. The capitate could be reduced to its normal relationship with the lunate, but it would not stay in position. Because of the fact that the injury was old, and scar tissue extensive, it was decided to remove the lunate and navicular bones. The patient was discharged from the hospital two weeks later, wearing an anterior plaster splint (Fig. 10-B). There was much less pain, and more motion in the wrist, but there was still considerable weakness. The patient was, therefore, fitted with a leather wristlet. One year later, the patient was working in a machine shop. There was less pain, and the wrist had improved in strength, but was still weaker than

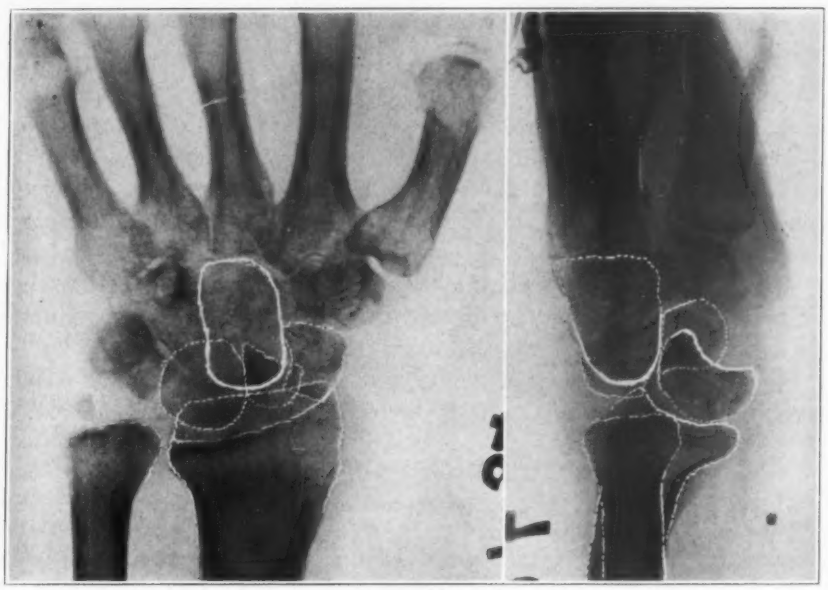

FIG. 10-A

Case 5. A. J. (No. 341976). Anteroposterior and lateral views of the hand two and one-half months after injury, showing retrolunar dislocation of the capitate, and fracture of the mid-position of the navicular with upward and backward displacement of the proximal fragment. All of the bones of the hand show marked atrophy.

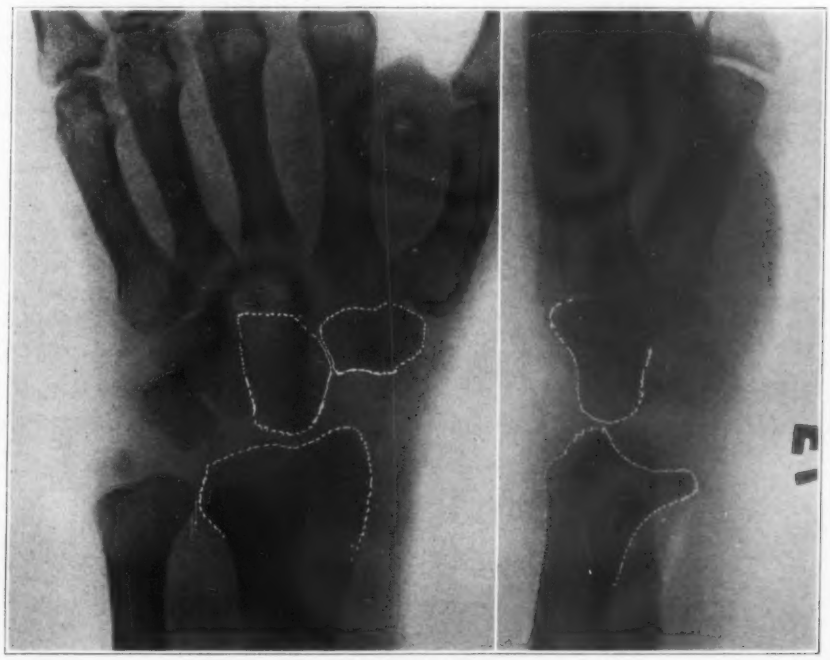

FIG. 10-B

Case 5. A. J. (No. 341976). Anteroposterior and lateral views after navicular and lunate have been removed. The capitate is still dorsally displaced.

the opposite one. There was slight radial deviation. The patient was wearing his wristlet while at work.

CONCLUSIONS

1. Retrolunar dislocation of the capitate bone with fracture or with subluxation of the navicular is one type of carpal injury.

2. Reduction of the dislocation by manipulation can be accomplished if done early. If this is not successful, open reduction must be carried out.

3. If there is an associated navicular fracture, and satisfactory alignment of the fragments is not obtained by manipulation, open reduction and insertion of a bone graft should be done.

4. In neglected cases of this type of injury, the choice of treatment rests between excision of the first row of the carpus and wrist fusion.

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THE CONSERVATIVE AND OPERATIVE TREATMENT OF FRACTURES OF THE CARPAL SCAPHOID (NAVICULAR) *

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Because of the well-deserved reputation for prolonged disability fractures of the carpal navicular have obtained considerable prominence in current medical literature. Another reason for the interest in this problem is the variety of operative methods which may be used in the treatment of fractures of the navicular which fail to unite. The purpose of this presentation is twofold: to show the end results of a group of acute fractures which were treated conservatively by a method previously described [24], and to evaluate the various operative measures which have been employed in the treatment of non-union.

TABLE I

Age of Patients	*No.*
10–19 years	7
20–29 years	18
30–39 years	15
40–49 years	6
50–59 years	4
Total	50

In 1934 the authors described the conservative treatment of sixteen cases of recent fracture of the carpal navicular, twelve of which resulted in bony union. During the past eight years fifty additional patients, with all types of fractures, have been treated. A tabulation of this series of fifty cases appears to form a satisfactory basis upon which to draw conclusions. The preponderance of males to females—forty-seven to three—doubtless results from the large proportion of industrial injuries. The maximum incidence occurred during the third and fourth decades of life, before attritional or senile changes appear (Table I). The duration of these fractures (Table II) permitted about one-half of them to be treated

TABLE II

Duration of Fracture	
Acute (up to 14 days)	19
Subacute (2 weeks to 6 months)	17
Old ununited fracture with reinjury	7
Old ununited fracture without reinjury	7
Total	50

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, New Orleans, Louisiana, on January 15, 1941.

TABLE III

TYPE OF FRACTURE SHOWN IN ROENTGENOGRAMS

Transverse through body without displacement	37
Transverse through body with displacement	3
Comminuted	6
Type not specified	4
Total	50

conservatively. The high incidence of fractures through the waist of the navicular (Table III) allows a considerable uniformity in their treatment. Associated injuries of the carpus, of which a dislocation of the lunate bone is the most common (Table IV), frequently alter the type of treatment required. Following the reduction of a ventral dislocation of the lunate bone, for example, it is advisable to assure prevention of a recurrence of the dislocation by immobilization of the wrist in some ventral flexion, rather than in the preferred position for navicular fractures.

TABLE IV

ASSOCIATED INJURIES IN THE WRIST

Dislocation of the lunate bone	6
Fracture of the lower end of the radius	3
Fracture of other carpal bone	1
Fracture of metacarpal bone	1
Total	11

The choice of treatment to be employed in the individual case (Table V) will be discussed later in this report. In Tables VI and VII, the end results in the entire series have been reported with regard to the occurrence of osseous union. Obviously, from this standpoint, the cases of excision of one or both fragments have no significance. The functional end result, as indicated by the ability to return to work, is shown in Table VIII.

Success in the treatment of the fractured carpal navicular depends upon an early recognition of the fracture and a complete and prolonged immobilization of the fragments. Of the various factors concerned in

TABLE V

TYPE OF TREATMENT

Conservative (cast in radial-dorsal flexion)		25
Operative		
Drilling operation	10	
Drilling and bone graft	8	
Excision of proximal fragment	6	
Excision of entire scaphoid	1	
Open reduction of fracture	2	
		27
Total		52*

* This figure includes one patient who had had conservative treatment with resultant non-union, and later a drilling and bone-graft operation; and a second patient who had had a drilling operation without union, and later an operation for the excision of the proximal fragment of the scaphoid.

TABLE VI

RESULTS OF CONSERVATIVE TREATMENT

In recent fractures		
Osseous union	20	
Non-union	1	
		21
In old ununited fractures with recent reinjury		
Osseous union	0	
Persistence of non-union (with subsidence of recent symptoms)	4	
		4
Total		25

TABLE VII

RESULTS OF DRILLING AND BONE-GRAFT OPERATIONS

Drilling operation		
Osseous union	5	
Doubtful union	2	
Non-union	2	
Result unknown	1	
		10
Bone graft and drilling operation		
Osseous union	6	
Non-union	1	
Result unknown	1	
		8
Total		18

the development of non-union, considerable importance must be attached to the blood supply of this bone. The chief artery enters through the tubercle, at the distal end of the bone, and one or more additional arterial foramina are found along various points of the body of the bone. Obletz and Halbstein found that the proximal half of the navicular had no foramina, or only a single foramen, in about one-third of the specimens studied. Aseptic necrosis is seen most frequently in small proximal fragments, and in such cases is a formidable obstacle to union. The absence of periosteum from most of the surfaces of the navicular (those covered with articular cartilage) is probably responsible for a retarded rate of healing, as compared with that of the long bones [15].

A rational approach to the prevention and treatment of non-union in any bone should be based upon a study of the microscopic changes

TABLE VIII

RETURN TO WORK

Returned to former type of work	36
Returned to lighter type of work	2
Did not return to work	1
Still under treatment	1
Result unknown	10
Total	50

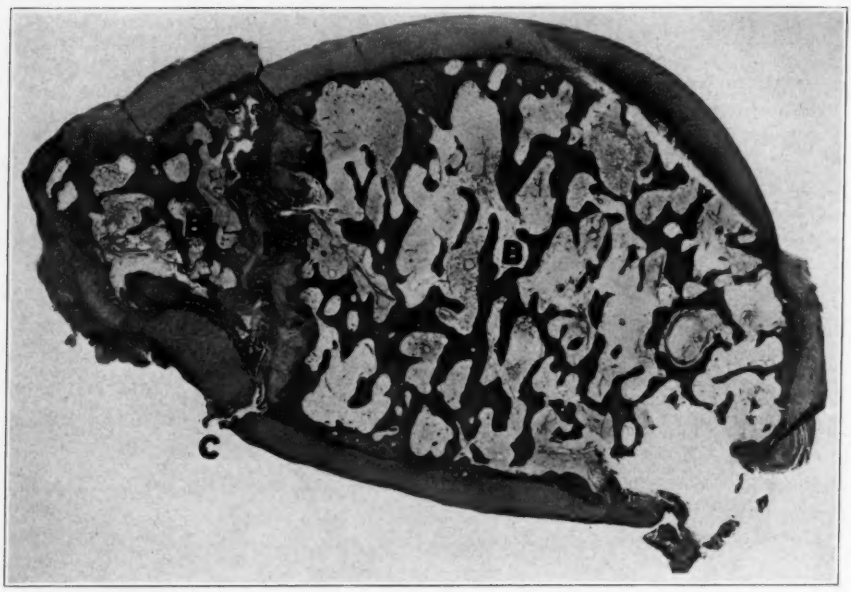

FIG. 1

Photomicrograph ($\times 7$) of proximal fragment of the navicular excised seven months after injury. The section shows an ununited fracture near one end of the excised fragment. Note the absence of callus, and the failure of the cartilage to heal. C = Cleft in the cartilage; F = Fibrosis along the line of fracture; and B = Cancellous bone.

which take place at the site of the lesion. The common observation in the roentgenograms of a progressive absorption of bone along the line of fracture has its counterpart in the picture shown by microscopic sections. Sections of five naviculars which were excised surgically show a character-

FIG. 2-A

A. R. Two days after injury the fracture cannot be seen.

FIG. 2-B

A. R. Five weeks after injury the fracture line is visible.

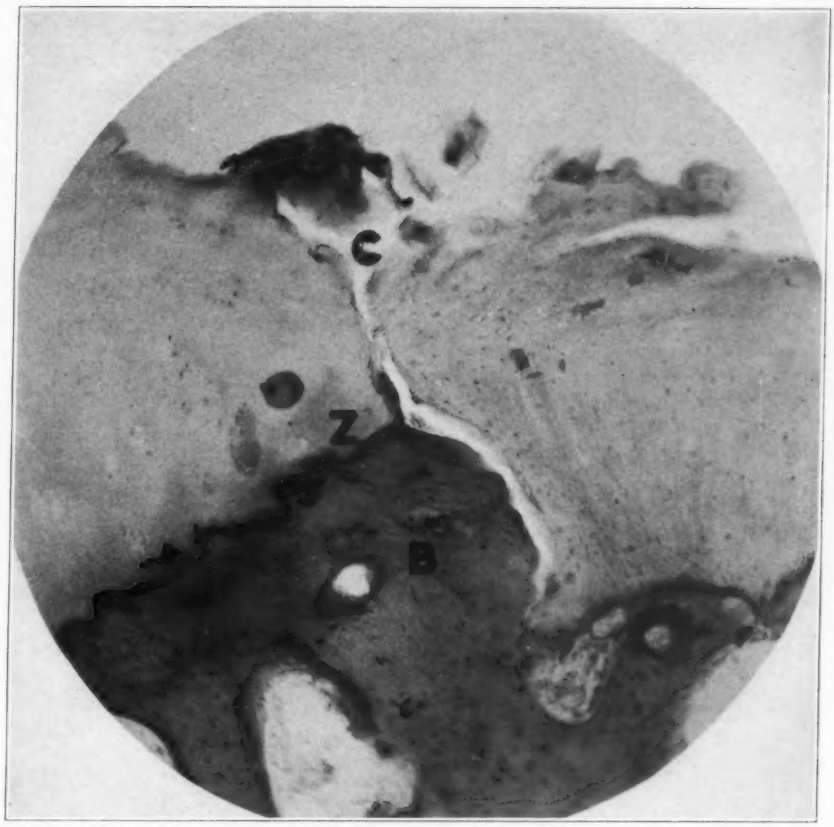

FIG. 3

Photomicrograph (× 100) of cleft in the cartilage of the proximal fragment of the navicular excised one year after injury. This view does not include the line of fracture through the bone. Note complete failure of the cartilage to heal.
C = Cleft in the cartilage; *B* = Subchondral bone; and *Z* = Zone of provisional calcification.

istic fusiform area of absorption which occurs along the line of fracture of those naviculars which have not been adequately immobilized (Fig. 1). The bone disappears and is replaced by fibrous connective tissue near the center of the fracture. This condition is sometimes referred to as cystic degeneration, although no true cyst of the bone occurs. Even if considerable absorption of this type is present, the insertion of a bone graft, or prolonged immobilization, often leads to a restoration of the normal appearance of the bone. Microscopic studies of these specimens (Fig. 3), and of other examples of injury to articular cartilage, have shown the complete inability of hyaline cartilage to regenerate [13]. The most that can be hoped for is a filling of the defect in the cartilage with connective tissue which slowly takes on some of the characteristics of fibrocartilage. It may be this failure of regeneration of cartilage which accounts for the persistence of pain in the wrist after osseous union of the fractured navicular has occurred.

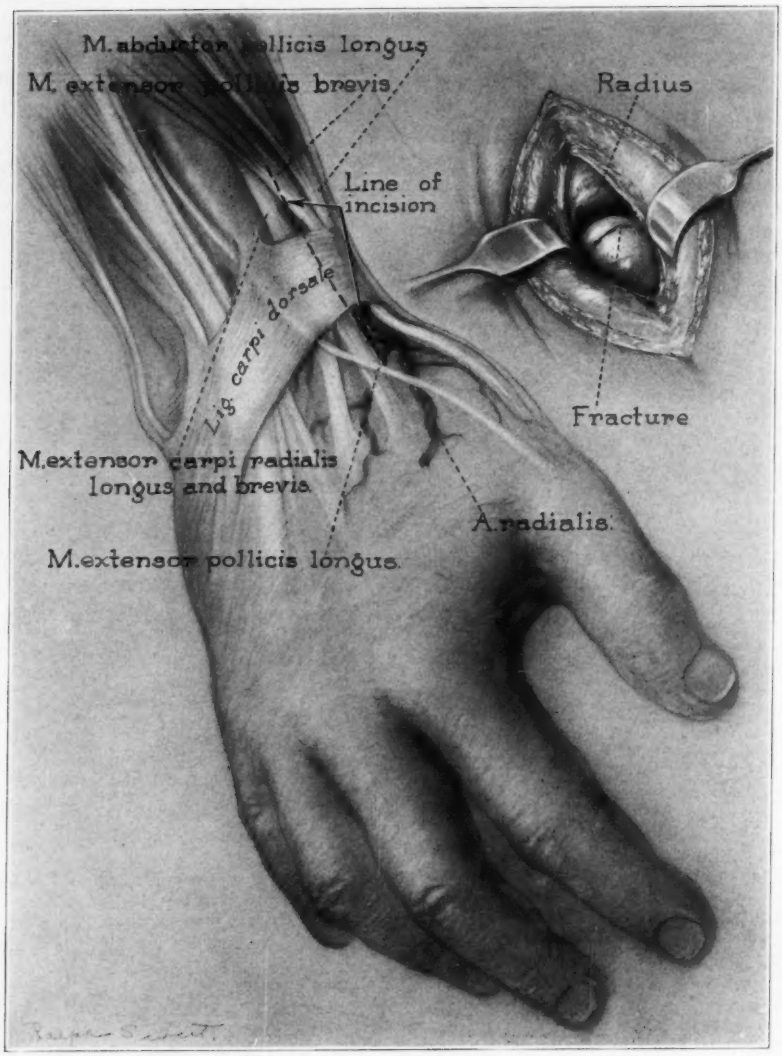

FIG. 4

Operative exposure of the navicular.

The most important causes of non-union in these fractures are ineffectual or insufficiently prolonged immobilization and, all too often, failure to make a diagnosis within the first two weeks after injury. The history of a blow on the palm of the hand, with the wrist in dorsiflexion, followed by immediate pain over the radial border of the wrist, should suggest the presence of a fracture of the navicular. If a fracture has occurred, there is usually tenderness, and occasionally fullness, over the anatomical snuffbox and on the dorsal and ventral aspects of the navicular. An important clinical sign is the occurrence of pain in the navicular region when percussion is made on the tip of the abducted thumb

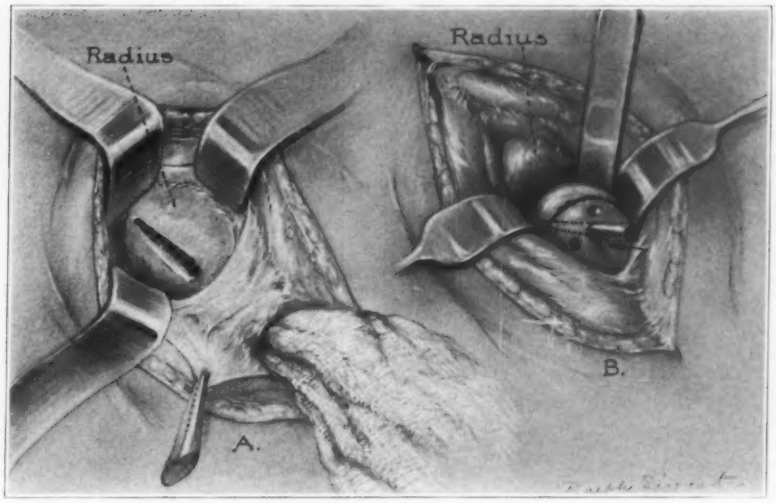

FIG. 5

Removal of the bone graft from the radius and its insertion into the navicular which has been drilled.

or over the distal end of the second metacarpal bone. Forced ulnar flexion of the wrist is usually painful.

Although roentgenographic examination is essential, and anteroposterior and oblique views should be taken with the wrist in full ulnar flexion, it must be emphasized that a negative roentgenogram immediately after injury does not eliminate the possibility of a fracture. If the clinical signs point to a navicular fracture, the patient should be treated as having such, and the roentgenographic examination should be repeated at the end of three weeks, at which time absorption of bone will have occurred along the line of fracture, and the roentgenogram will give the true diagnosis. Two cases in our series illustrate this point (Figs. 2-A and 2-B). It is most important that the treatment begin immediately after the injury has occurred, even at the risk of immobilizing a wrist in which no fracture is subsequently demonstrated, because the chances of success in conservative treatment rapidly fade with the passage of time between injury and immobilization.

In a consideration of the treatment of fractures of the navicular, their classification should be both anatomical and chronological. The anatomical grouping includes (1) lesions of the body, through the waist, (2) lesions through the proximal pole, (3) lesions of the tubercle, and (4) comminuted fractures. Chronologically they may be grouped as recent—up to two weeks—and old. The term subacute may include the borderline cases. Recent fractures through the body or proximal pole of the navicular should be immobilized by a cast which holds the wrist in full radial flexion and 30 degrees of dorsiflexion, and includes the thumb which is held in full abduction and extension, in the manner previously described by the authors [24]. In the application of the cast including the

FIG. 6-A

L. S. November 1, 1937, five days after injury.

FIG. 6-B

L. S. March 8, 1938, four and one-half months after injury, there is increased density (aseptic necrosis) of the proximal fragment of the navicular.

FIG. 6-C

L. S. October 10, 1940, three years after injury, the fracture is healed following drilling and insertion of the bone graft. Note the equal density of the fragments.

thumb, care must be taken to force the thumb into abduction by pressure on its base, rather than on its tip, because the latter procedure may lead to a slight subluxation of the metacarpophalangeal joint of the thumb. The thumb is released after six weeks, but immobilization of the wrist may be necessary for from three to six months. At the end of ten or twelve weeks, a reinforced leather wrist support, which includes the hand, may be used for the more prolonged immobilization. Fractures of the tubercle of the navicular usually heal after from four to six weeks of immobilization, which need not include the thumb. The existence of marked comminution of the navicular usually precludes a satisfactory functional result with conservative treatment, and may be an indication for the excision of the fragments, which should be done early in order to avoid arthritic changes in the wrist. As previously noted, primary attention must sometimes be paid to associated injuries of the carpus.

In the treatment of less recent cases of fracture, an early decision

regarding the operative procedure to be employed is important in order to shorten the period of disability, and to prevent arthritic changes in the wrist, as evidenced by the sharpening of the styloid process of the radius, which is commonly seen in old ununited fractures of the navicular. In the earlier cases of this series the operation of drilling, introduced by Schnek was used but is now reserved for those naviculars which do not show extensive absorption at the line of fracture. The authors' experience showed that healing was very slow following the drilling operation, and that osseous union could be anticipated in only about one-half of the cases. The unfavorable cases were those in which the roentgenograms showed absorptive changes. Pathological studies have convinced the authors that simple drilling does not sufficiently stimulate osteogenesis. They have, therefore, altered their technique (Figs. 4 and 5) to include the exposure of the site of the fracture, the excision of all fibrous tissue lying between the fragments, multiple drilling through both fragments, and the introduction of one or two bone grafts [1, 20]. The removal of the bone peg from the cortex near the distal end of the radius and its insertion through a hole which enters the distal fragment near the tubercle and penetrates the proximal fragment, does not unduly complicate the operation, and certainly favors union by the addition of osteogenic tissue and the provision of internal fixation of the fragments.

Excision of the proximal ununited fragment of the navicular seems advisable when this fragment is too small to permit the insertion of a bone graft. This operation has also been employed for the occasional patient upon whom a bone graft or drilling operation was unsuccessful. Its use in comminuted fractures has been cited. Although the presence of aseptic necrosis of the proximal fragment would seem to require its excision, the authors have seen the revascularization and osseous union of such a fragment following the insertion of a bone graft (Figs. 6-A, 6-B, and 6-C).

CONCLUSIONS

1. Success in the treatment of fractures of the carpal navicular depends upon the recognition of the fracture within two or three weeks of injury, and upon adequate and prolonged immobilization. Under these favorable conditions osseous union may be anticipated in a very high percentage of cases.

2. Excision of one or both fragments of the navicular is reserved for a limited number of cases, including those showing marked comminution and those in which other measures have failed.

3. From further experience in the operative treatment of non-union, it would seem that the drilling operation has a limited value; and that a procedure is indicated which combines the excision of the interposed fibrous tissue, the drilling of the bone, and the insertion of a bone graft from the radius. This procedure materially reduces the period of necessary immobilization and increases the chances of union.

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AN EVALUATION OF PHYSIOTHERAPY IN THE EARLY TREATMENT OF ANTERIOR POLIOMYELITIS *

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Poliomyelitis exists in endemic form in this country, but few clinics have at their disposal a series of acute cases of the true epidemic form large enough to permit a comparative study of the various therapeutic measures most frequently used. Prior to 1933, it was unusual for a case of poliomyelitis in the acute or subacute stage to be seen at Shriners' Hospital, although patients with the chronic form outnumbered those with any other disease process accepted for treatment. During the year 1935, forty-one recent cases were observed; in 1936, sixty-three cases; in 1937, forty-five cases; and in 1938, eleven cases. During this four-year period, a total of 160 cases (325 involved extremities) were seen, and these have now been followed long enough to state definitely the degree of residual involvement which they show, and therefore to determine the value of the treatment used in each case.

The first group, in 1935, were treated by immobilization in solid plaster until all evidence of muscle tenderness, and muscle and joint pain had disappeared,—usually a period of three to four months. This was followed by immobilization in plaster splints or bivalved plasters with the paralyzed muscles relaxed, and physiotherapy treatments five days each week, in the pool at a temperature of about 95 degrees Fahrenheit. Each treatment lasted about twenty minutes. At the end of nine months, when it was possible to ascertain with some measure of certainty the residual involvement, the results were found to be very disappointing.

It was at this time that the authors learned of the excellent results which had been obtained by Kendall by means of prolonged immobilization, and prolonged rest and protection, and it was decided to give the method a thorough trial should a similar epidemic occur in 1936. It became necessary at about this time to obtain a new physiotherapist, so one trained by Mr. Kendall was secured. The work with the next series of patients was more or less turned over to her as it was felt that, to give this method an impartial trial, the work should be done by some one thoroughly familiar with his ideas and the details of his method of treatment. In order to facilitate the ease of handling these patients and to assure every possible advantage for the patients and for the method at trial, one entire ward was set aside solely for their care. Thirty patients were admitted during the course of a few days and remained for approximately nine months under constant observation. It was the authors' privilege

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, New Orleans, Louisiana, January 14, 1941.

to have a visit from Mr. Kendall during this time to check the methods being employed, to discuss any changes which might be beneficial, and to assure close adherence to his ideas. Much to the authors' surprise, however, the results in that year were no better than in the previous year, and the percentage of patients actually showing improved muscle power, as a result of the new treatment, was no greater.

During the next two years no one single plan of therapy was followed. The patients were treated in various ways, depending on the needs of each individual. No attempt will be made to discuss the details of the various recommended procedures as these have been adequately described by the proponents of each method [1,2,4,5,6,7]. These have varied from prolonged immobilization on the one hand, to intensive physiotherapy, which entirely disregarded immobilization and rest even in the very acute stage and carried all joints through a full range of motion at frequent intervals, on the other. The latter method (Sister Kenny's), originating in Australia, has not been tried in cases supervised by the authors, and as yet has had very little intentional application in this country. Between these two extremes lie those methods which adhere to various periods of early immobilization, accompanied or followed by some form of physiotherapy. The usual and probably the most popular form of physiotherapy used in this country today is the underwater therapy.

An attempt has been made to analyze critically the results in this series of 160 cases without preconceived ideas as to the relative value of any particular form of therapy. The analysis itself is extremely difficult, and it is questionable whether or not one is justified in attempting to estimate the return of function in an extremity as a whole. To record an analysis of such a series from the standpoint of function in each individual muscle of the body, however, would require volumes of space, and the fundamental facts would be lost in a maze of figures. Therefore, an attempt has been made to estimate the residual function in an involved extremity and to compare this with the original involvement. For the original involvement only two listings have been used: (1) those extremities showing complete paralysis, including those in which no muscle is rated better than poor, and (2) those showing partial paralysis as evidenced by spotty changes or generalized weakness. For the estimated residual function in those extremities five classifications have been used:

1. ZERO. Completely flail extremity or one with a few muscles showing no more than a trace in power.

2. POOR. Slight return, but with muscles rated no better than poor and consequently of little or no functional value.

3. FAIR. Fair return in most muscles and perhaps good in a few, but with insufficient return in the more important muscles to permit a brace-free extremity. Such an extremity, even though a brace is required, is rendered fairly satisfactory, because the muscles are of considerable functional value.

4. GOOD. A satisfactory brace-free extremity. This means at least good return in the major muscles, but with some residual involvement. Extremities with good muscles about the hip and knee, but with residual involvement of muscles about the foot, are listed in this group.

5. NORMAL. Those extremities with no demonstrable residual involvement.

The same criteria have been used in estimating the return of power in the muscles of the upper extremity, except for the necessity of using apparatus. Upper extremities are frequently seen with the deltoid paralyzed, while the remainder of the extremity shows little or no involvement. Such extremities have been classified as good. It is obvious that such a classification is based on a rough estimate of the residual involvement. It is justified, however, since the amount of function which an extremity shows determines the value of the therapy used.

For a comparative study, all cases in this series have been grouped according to the type of treatment used. Table I shows seventeen cases (thirty extremities) which were treated by short periods of complete immobilization with no form of physiotherapy. This period of immobilization lasted from one to four months. The extremity was then protected by a brace and the individual was allowed up.

Table II shows six cases (ten extremities) treated by short periods of complete fixation for from one to three months and followed by physiotherapy for from three to six months. Protection of the extremity during the period of physiotherapy was maintained by plaster splints or specially prepared braces to prevent active use. Physiotherapy consisted of limited active and passive motion either in the pool, or on a table, in which case each treatment was preceded by baking and massage of the involved extremity. These treatments averaged about twenty minutes daily for five days each week.

TABLE I

SUMMARY OF THIRTY EXTREMITIES TREATED BY SHORT PERIODS OF IMMOBILIZATION OF ONE TO FOUR MONTHS WITHOUT PHYSIOTHERAPY *

Involved Part and Degree of Original Involvement	No.	Final Rating				
		Zero	Poor	Fair	Good	Normal
Arms						
Complete paralysis						
Partial paralysis	6				3	3
Legs						
Complete paralysis	15	4	5	3	2	1
Partial paralysis	9			1	8	
Total extremities	30	4	5	4	13	4

* Of three patients with paralysis of the abdominal muscles, two had a final rating of poor and one, fair.

TABLE II

SUMMARY OF TEN EXTREMITIES TREATED BY SHORT PERIODS OF IMMOBILIZATION OF ONE TO THREE MONTHS IN SOLID PLASTER FOLLOWED BY PHYSIOTHERAPY FOR THREE TO SIX MONTHS *

Involved Part and Degree of Original Involvement	No.	Final Rating				
		Zero	Poor	Fair	Good	Normal
Arms						
Complete paralysis						
Partial paralysis	1			1		
Legs						
Complete paralysis	4			3	1	
Partial paralysis	5			1	4	
Total extremities	10			5	5	

* Of two patients with paralysis of the abdominal muscles, one had a final rating of poor, and one of good.

Table III shows the results obtained in thirty-eight cases (seventy-five extremities) treated by prolonged immobilization for from four to eighteen months with no physiotherapy. For the most part this immobilization consisted of absolute fixation in solid plaster, and the remainder of the period in bivalved plasters or plaster splints.

Table IV shows an analysis of twenty-two cases (sixty-two extremities) treated by prolonged plaster immobilization followed, after three to twelve months, by continued immobilization and accompanying physiotherapy. Fixation of some form with no free active use of the extremity was maintained in all cases for periods of from eight to twenty-four months.

TABLE III

SUMMARY OF SEVENTY-FIVE EXTREMITIES TREATED WITH PROLONGED PLASTER IMMOBILIZATION OF FOUR TO EIGHTEEN MONTHS WITHOUT PHYSIOTHERAPY *

Involved Part and Degree of Original Involvement	No.	Final Rating				
		Zero	Poor	Fair	Good	Normal
Arms						
Complete paralysis	8		1	4	3	
Partial paralysis	7			1	4	2
Legs						
Complete paralysis	49	23	11	13	2	
Partial paralysis	11		1	5	5	
Total extremities	75	23	13	23	14	2

* Of the eleven patients with paralysis of abdominal muscles, two had a final rating of zero; six, poor; and three, fair.

TABLE IV

SUMMARY OF SIXTY-TWO EXTREMITIES TREATED WITH PROLONGED PLASTER IMMOBILIZATION OF THREE TO TWELVE MONTHS AND LONGER, FOLLOWED BY PHYSIOTHERAPY FOR EIGHT TO TWENTY-FOUR MONTHS *

Involved Part and Degree of Original Involvement	No.	Final Rating				
		Zero	Poor	Fair	Good	Normal
Arms						
Complete paralysis	14		1	7	6	
Partial paralysis	9				4	5
Legs						
Complete paralysis	28	13	6	8	1	
Partial paralysis	11			1	6	4
Total extremities	62	13	7	16	17	9

* Of the fourteen patients with paralysis of the abdominal muscles, one had a final rating of zero; six, poor; three, fair; two, good; and two, normal.

There are fourteen cases (nineteen extremities) listed in Table V in which delayed plaster immobilization was carried out over periods of from six to eighteen months in an attempt to improve function in extremities which were extensively involved. These patients were not seen by the authors in the beginning, and were not referred to this Hospital until several months after the onset of the paralysis. Immobilization was carried out by means of solid plaster with no physiotherapy. There might also be included in this group eighteen lower extremities and five upper extremities, already included in one of the first four tables, which

TABLE V

SUMMARY OF NINETEEN EXTREMITIES WITH DELAYED PLASTER IMMOBILIZATION OF SIX TO EIGHTEEN MONTHS IN AN ATTEMPT TO IMPROVE POWER (AFTER FOURTEEN MONTHS AND LONGER) *

Involved Part and Degree of Original Involvement	No.	Final Rating				
		Zero	Poor	Fair	Good	Normal
Arms						
Complete paralysis	1		1			
Partial paralysis	1					1
Legs						
Complete paralysis	13	6	6	1		
Partial paralysis	4			1	3	
Total extremities	19	6	7	2	3	1

* Of the three patients with paralysis of the abdominal muscles, one had a final rating of zero, and two, poor.

were later given additional complete plaster fixation of from six to twelve months because of extensive residual involvement. Not one in this latter group showed any improvement in muscle power as a result of the immobilization.

During this same four-year period, there was an additional series of sixty-three cases (129 extremities) shown in Table VI, which received no treatment whatever. These were patients who for the most part lived in inaccessible communities, and who usually were without the immediate services of an orthopaedic surgeon or physiotherapist. These patients were kept in bed only during the acute illness, and most of them were made to attempt to walk as soon as they could venture out of bed. In many instances, the parents felt that the paralysis would progress unless the child was forced to use the involved extremities and exercise them as much as possible. These patients were seen in the Clinic from six weeks to twelve months after the acute illness, and at the time either showed so much recovery that treatment in an attempt to improve the muscle power was not justified, or showed so extensive residual paralysis several months after the onset that treatment was thought to be a futile gesture. Since these patients did not have accurate muscle charts made early in the process, it may be argued that considering them in this discussion is not justified. The parents, however, were questioned as to whether the involved extremity in each instance showed complete or partial paralysis. This was determined by whether or not the patient lost all ability to move the extremity in question. If the extremity could not be actively moved, it was felt safe to assume that there was extensive involvement and to classify it as completely paralyzed. When some ability to move the extremity remained, the involvement was listed as partial paralysis.

The recovery of the involved abdominal muscles has not been con-

TABLE VI

SUMMARY OF 129 EXTREMITIES IN WHICH NO TREATMENT WAS USED *

Involved Part and Degree of Original Involvement	No.	Final Rating				
		Zero	Poor	Fair	Good	Normal
Arms						
Complete paralysis	28	2	2	4	9	11
Partial paralysis	12				8	4
Legs						
Complete paralysis	58	9	6	6	30	7
Partial paralysis	31		1	5	22	3
Total extremities	129	11	9	15	69	25

* Of the eight patients with paralysis of the abdominal muscles, one had a final rating of zero; two, poor; three, fair; one, good; and one, normal.

TABLE VII

RESULTS IN EXTREMITIES FOR EACH GROUP REGARDLESS OF DEGREE OF ORIGINAL INVOLVEMENT

Group and Treatment	Total No.	Zero		Poor		Fair		Good		Normal	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Group I Immobilization 1 to 4 months No physiotherapy	30	4	13	5	17	4	13	13	44	4	13
Group II Immobilization 1 to 3 months Physiotherapy 3 to 6 months	10	0	0	0	0	5	50	5	50	0	0
Group III Immobilization 4 to 18 months No physiotherapy	75	23	30	13	17	23	31	14	19	2	3
Group IV Immobilization 3 to 12 months Physiotherapy 8 to 24 months	62	13	21	7	11	16	26	17	27	9	15
Group V Delayed plaster immobilization 6 to 18 months	19	6	31	7	37	2	11	3	16	1	5
Group VI No treatment	129	11	9	9	7	15	12	69	53	25	19
Totals	325	57	18	41	12	65	20	121	37	41	12

sidered in the above discussion. Those with definite involvement have been mentioned as footnotes to the accompanying tables, with the recovery shown in each instance. Treatment for these has consisted in an attempt to maintain relaxation in the abdominal wall at all times by keeping the patient on a flexed Bradford frame, or elevating the chest, shoulders, head, and neck on pillows. When a position of 10 degrees to 15 degrees or more of flexion is maintained for several months, many patients will develop flat chests and round shoulders. Such treatment, therefore, must be carried out within reason. Any patient who showed any indication of abdominal involvement was fitted with a Hoke type of corset before being allowed to sit up. In spite of this precaution, a definite scoliosis has already developed in twenty-one of these patients, or in about 13 per cent. of the total series. In two cases with distinct uni-

TABLE VIII

RESULTS FOR GROUPS COMBINED ACCORDING TO DEGREE OF ORIGINAL INVOLVEMENT

Degree of Original Involvement	Total No.	Zero		Poor		Fair		Good		Normal	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Extremities with initial complete paralysis...	218	57	26	39	18	49	22	54	25	19	9
Extremities with initial partial paralysis...	107	0	0	2	2	16	15	67	63	22	20
Totals.....	325	57	18	41	12	65	20	121	37	41	12

lateral involvement, fascial transplants to the abdominal wall have been used in an attempt to splint the weak side and prevent further increase in the deformity, but insufficient time has elapsed to make any statement in regard to the result.

DISCUSSION

By a study of the tables, it can be readily seen that no particular form of therapy produced results which were outstanding. In fact, the highest percentage of satisfactory brace-free extremities occurred in that group of patients who received no treatment during the early stages, and who began to walk without support as soon as they could get out of bed.

The degree of initial paralysis was of far greater value in determining the degree of residual involvement than was the type of treatment used. Classifying all groups together, there were 218 extremities showing complete paralysis at the onset, and 107 extremities showing only partial paralysis. Final rating in each of these is shown in Table VIII.

Since early muscle charts were not obtained in the group that received no treatment, some may object to our assumption that some of these showed complete paralysis in the beginning. Let us assume then that none of these patients showed complete paralysis in the beginning, and classify all sixty-three patients (129 extremities) as having had original partial paralysis. Table IX shows that even then the results in this group compare very favorably with the combination of extremities from all other groups which showed only partial involvement in the beginning, and even the strongest objector will have to grant us the right to classify as complete paralysis those extremities which still remain flail or are now rated no better than poor. This change in the table will leave the group receiving no therapy with more brace-free extremities today—63 per cent. good and 23 per cent. normal—than the extremities showing only partial initial involvement in the combined therapeutic groups.

It seems safe to assume, therefore, that in the final analysis, the

TABLE IX

COMPARISON OF RESULTS BETWEEN ENTIRE GROUP THAT RECEIVED NO TREATMENT AND THE EXTREMITIES OF ALL OTHER GROUPS THAT SHOWED ONLY PARTIAL PARALYSIS AT ONSET

Group and Treatment	Total No.	Zero		Poor		Fair		Good		Normal	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Group VI											
No treatment.....	129	11	9	9	7	15	12	69	53	25	19
Combined extremities with original partial paralysis in all groups receiving therapy....	64	0	0	1	2	11	17	37	58	15	23
Totals.....	193	11	6	10	5	26	13	106	55	40	21

results in anterior poliomyelitis can be more adequately explained on the basis of the underlying pathological process than on the form of the early treatment which is used. Initial paralysis in many instances is on the basis of a block in the pyramidal tracts from localized oedema or hemorrhage without actual destruction of the ganglion cells. Such a paralysis is temporary in character; and muscle function returns with relief of pressure from the anterior horn cells with the subsidence of the oedema. Instances of only partial paralysis of an extremity in the beginning can easily be explained on this basis, and could account for their higher percentage of satisfactory results. Those extremities showing satisfactory functional return, in spite of apparent initial complete paralysis, can also be explained on this basis. If, instead of this temporary pressure paralysis, however, the anterior horn cells are actually destroyed, the muscles supplied by those nerve cells will remain completely paralyzed regardless of the type of treatment. In those cases with complete paralysis at the onset in one or more extremities, one can imagine a more destructive underlying pathological process. This actual destruction of nerve cells, rather than a temporary pressure block of the pyramidal pathway, probably accounts for the lower percentage of satisfactory returns in such cases.

The authors do not wish to imply from this that all orthopaedic measures should be discarded in the treatment of the acute stages of this disease. Careful immobilization should be used for three reasons: (1) for the comfort of the patient during the acute stage, (2) to prevent the early development of deformities in an extremity as the result of muscle imbalance, and (3) to prevent a stretch paralysis in a partially paralyzed muscle. That this can and does occur at times is evidenced by the fact that after the correction of deformities, return of power is occasionally noted in muscles which have been stretched over a long period. To be perfectly honest, it must be admitted that otherwise treatment has little

or no effect on the course of the disease. The type of treatment used in the authors' experience is of minor importance in restoring power to the paralyzed muscles, but may be used so long as that plan is carried out within reason and is not actually harmful to the involved muscles.

The continuation of physiotherapy over a period of years has often been used in the hope of obtaining some evidence of recovery in involved muscles. For patients who can afford such care and who do not have to consider the great economic side of this problem, such a plan may be ideal. Recovery in paralyzed or partially paralyzed muscles is not of as great importance in these patients, however, as their psychological well-being. If an extremity shows power enough to be rendered brace-free and functionally satisfactory by stabilizing operations and muscle transplants with a loss of time of only three to four months, it is not justifiable to substitute prolonged physiotherapy over a period of years in an attempt to accomplish a result which would functionally be no better. For the vast majority of patients who are compelled to consider the economic aspect of this question, this would seem to be a more sensible solution to their problem. In those patients with essentially flail extremities, it is not justifiable to prolong active physiotherapy in order to obtain an increase in power of involved muscles of as much as 10 to 15 per cent. After reasonable time has elapsed, it is better to permit this patient to be up with a brace and to utilize this time in adapting himself to the use of the brace and in learning some trade whereby he can carry on an independent existence throughout his life.

This question of how long treatment and immobilization should be continued before full active use of the extremity and weight-bearing are permitted, is extremely difficult to answer.

In the lower extremity, if there is residual involvement only about the foot with the rest of the extremity good or normal, the authors feel that this foot can be adequately protected in a brace and the child can as a rule be permitted up safely after three to four months. If no further recovery takes place in the foot, a satisfactory brace-free extremity can still be obtained by stabilization of the foot and muscle transplants, necessitating a minimum loss of time to the patient. If the entire extremity is involved, and is showing no evidence of improvement in power, as is frequently the case when the extremity is completely flail, weight-bearing is allowed with a brace after six months. While such may occasionally occur, the authors have seen no completely paralyzed extremity or muscle, which had been under adequate care and which remained flail six months after the onset of the paralysis, show a return of power sufficient to be of functional value, regardless of the form of treatment. If the muscles can be rated as high as fair and are still improving in power, immobilization should be continued until recovery is at a stationary point. The authors have set no exact time limit on this, but Bennett and Lenhard state that in their series all recovery was complete by the end of eighteen months. The authors do not feel that prolonging immobilization and physiotherapy over a

period of years is in any way indicated. Cases are seen in which prolonged immobilization and prolonged physiotherapy will increase the power of an involved muscle as much as 10 per cent., or increase from a trace to a rating of poor, but such is of little benefit to the patient, and is of little or no functional value. Such an improvement on a muscle chart is often construed as tremendously important. Unless the amount of improvement is sufficient to render the muscles of value from a functional standpoint, prolonged periods of immobilization and physiotherapy are not justified.

In the upper extremity, the same general plan of treatment is followed. If there is evidence of improvement, immobilization and protection are continued, but if an involved muscle remains completely paralyzed for six months, in spite of adequate constant protection and care, as is often the case in the deltoid, there is no reason for prolonging the active treatment.

SUMMARY

The results in this series of 160 cases of recent anterior poliomyelitis extending over a four-year period seem to indicate that the type of early treatment has little or no effect on the course of the disease and alters little, if any, the degree of residual paralysis which is seen.

Clinical evidence shows that the amount of residual involvement is primarily dependent on the degree of initial paralysis and the amount of actual destruction which has taken place in the anterior horn cells. There is no way of accurately determining this during the acute illness, but it is at this time that the die for the final picture is cast, and orthopaedic measures probably alter little, if any, the course of the disease.

Immobilization and protection are indicated for three reasons: (1) the comfort of the patient during the acute stage, (2) the prevention of deformities, and (3) the prevention of stretch paralysis in the involved muscles.

Therefore, the early orthopaedic measures actually employed are of little importance in restoring power to the paralyzed muscles, but may be used so long as they are not actually harmful to the involved muscles.

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THE INTERMUSCULAR, LATERAL APPROACH FOR REMOVAL OF A CERVICAL RIB *

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Several years ago the author had occasion to operate on a rather large cervical rib. The rib produced a considerable bulge on the side of the neck, and was so readily palpable that it seemed subcutaneous. The best way to remove this rib appeared to be the most direct approach through an incision on the lateral aspect of the neck directly in front of the trapezius muscle, instead of through an anterior horizontal incision over the sternomastoid muscle, which is far removed from the lateral surface of the vertebra, and hence from the proximal extremity of the rib. The lateral approach was used and the removal of the rib was found to be very simple. The author believes that it is not adequately appreciated that the lateral mid-cervical approach permits an unusually easy access to a cervical rib through an avascular, intermuscular route. He has used this avenue several times and on each occasion has found it safe, adequate, and satisfactory.

ANATOMY

In studying a cross section of the neck (Fig. 1), it is found that the cervical spine divides the neck into an anterior, prevertebral compartment containing the larynx, trachea, oesophagus, large blood vessels, the cervical and brachial plexuses, and many muscles, and a posterior compartment containing chiefly muscles arising from, or attached to, the posterior part of the skull and the lateral and posterior cervical vertebral processes. These compartments are separated laterally by extensions of the deep cervical fascia, which attach to the transverse processes of the cervical vertebrae. Thus at the level of the seventh cervical vertebra a cervical rib has its origin between the muscle groups of the prevertebral and postvertebral compartments. Moreover, it may be noted that at this site (Fig. 2), there are no important vessels or nerves requiring special attention. The spinal accessory nerve enters the trapezius considerably above the level of the seventh cervical, and the transverse cervical artery is below it. One might perhaps cut a few fibers of the supraclavicular cutaneous branches of the cervical plexus, but this is not a serious sacrifice. This arrangement of the tissues permits intermuscular access to the transverse process of the seventh cervical vertebra, and hence to a cervical rib.

TECHNIQUE

An oblique incision of two and one-half inches, parallel to the creases of the neck, is made in the posterior triangle of the neck a little below the

* Read before the Orthopaedic Section of the New York Academy of Medicine, February 21, 1941.

level of the cricoid cartilage, with the middle of the incision opposite the seventh cervical vertebra (Fig. 3). The superficial fascia and platysma are cut, exposing the deep fascia, which is incised vertically and retracted, exposing the trapezius posteriorly. The trapezius and the deep fascia are retracted backward. The tissues seen in the wound are, from before backward, the upper trunk of the brachial plexus, the scalenus medius and posterior and the levator scapulae. By gently retracting the levator scapulae backward, and the scalenus posterior forward the base of the cervical rib is immediately encountered (Fig. 4). The scaleni (posterior and median) are then gently elevated, exposing the entire length of the cervical rib and, when present, the fascial or aponeurotic band extending downward and forward from its tip. By cutting the rib near its origin, it can be raised from its bed to its very tip; the restraining tissues, including the fascial band, can be severed, and the rib liberated, freeing the plexus of the pressure caused by the rib and its band. The rib and the fascial band can be removed without the hazard of in-

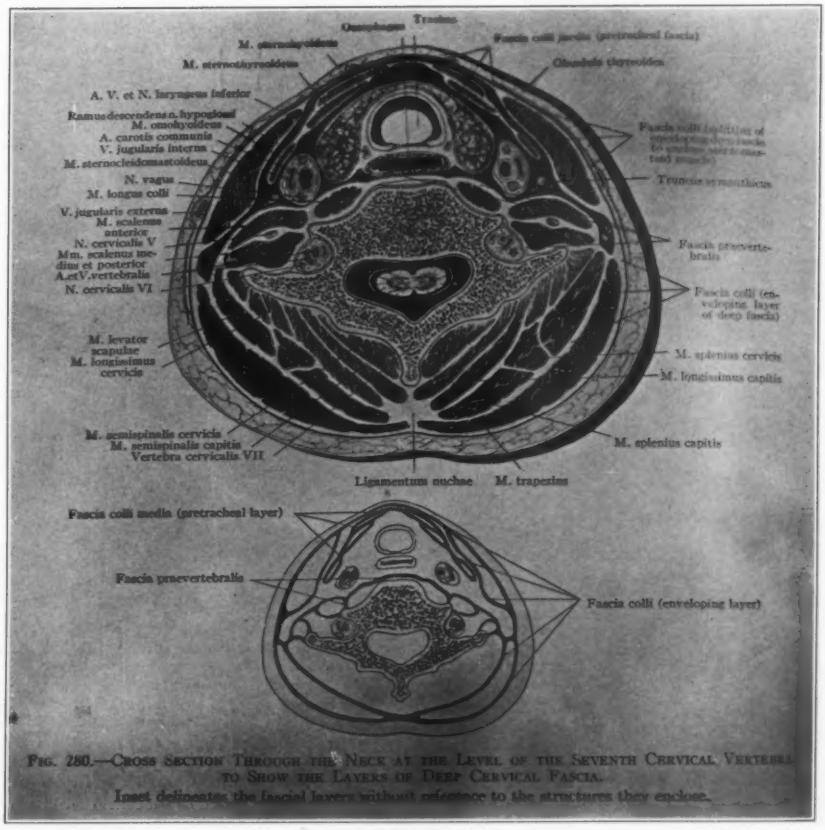

FIG. 280.—CROSS SECTION THROUGH THE NECK AT THE LEVEL OF THE SEVENTH CERVICAL VERTEBRA TO SHOW THE LAYERS OF DEEP CERVICAL FASCIA.

Inset delineates the fascial layers without reference to the structures they enclose.

FIG. 1

This section, from Callander's Surgical Anatomy, shows the intermuscular position of the transverse processes of the seventh cervical vertebra. (*Courtesy of W. B. Saunders Company.*[3])

jury to any vessels or nerves. In fact in this method of exposure the brachial plexus may not be seen, and need not be exposed. On the other hand, should it be desirable to inspect the scalenus anterior, it can readily be done by retracting the cut inner edge of the deep cervical fascia. When the rib is very large, bulging the scaleni forward, it may be advantageous to identify the interval between the posterior and median scaleni, retract them in opposite directions, and thus reach and expose the rib, perhaps more easily than in the plane between the scalenus posterior and the levator scapulae.

When a cervical rib causes symptoms, they are identical with those of the so-called scalenus anterior syndrome, and are due to a constriction of the space through which the brachial plexus and the subclavian artery pass from the neck into the axilla, with resultant abnormal pressure upon the plexus and the artery. The object of treatment is to relieve the pressure and irritation by enlarging the space for the plexus of nerves and the subclavian artery. This should be possible through either the removal of the anomalous rib, or division of the scalenus anterior muscle. There are cases, many of them, with classical symptoms, in which there is no cervical rib. In these instances the anterior approach, popularized by Adson and Coffey is preferable, because it affords a thorough exposure

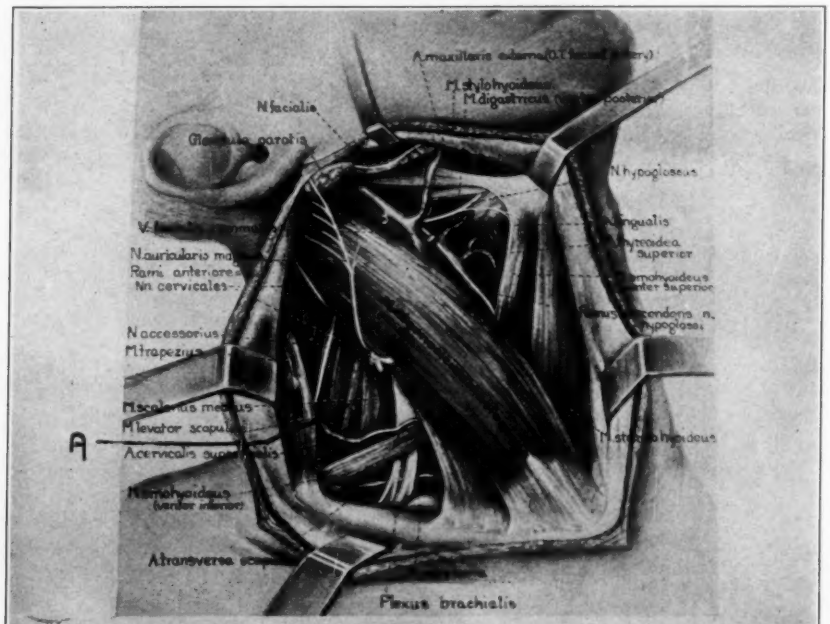

FIG. 340.—STRUCTURES OF THE LATERAL REGIONS OF THE NECK WITH THE STERNOCLEIDOMASTOID MUSCLE IN SITU.

FIG. 2

This photograph is also a copy of one in Callander's Surgical Anatomy. It shows that at the site of the transverse process of the seventh cervical vertebra, and hence the usual position of a cervical rib, there are no large or important vessels or nerves (*A*). (*Courtesy of W. B. Saunders Company.*[3])

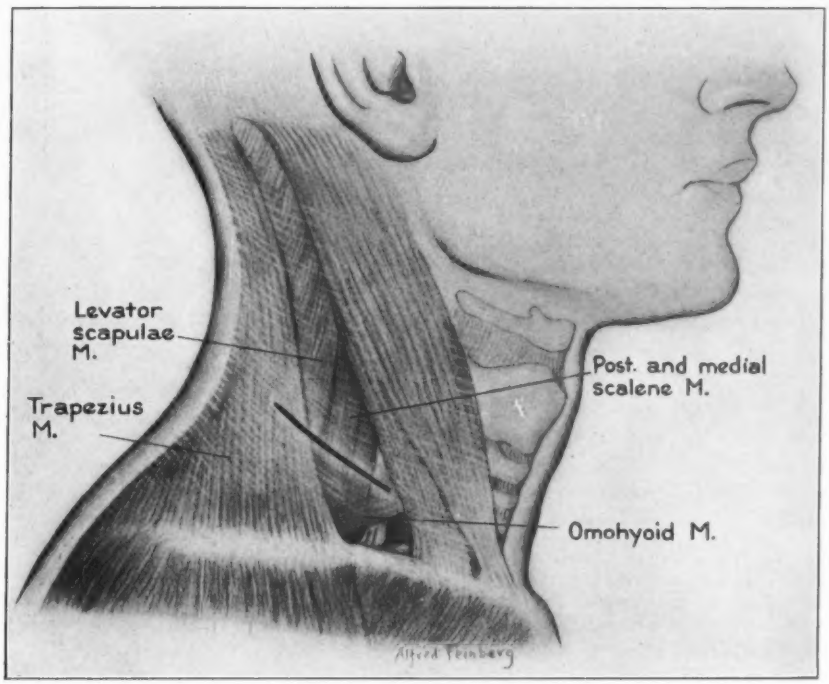

FIG. 3

The oblique dark line indicates the incisional approach for the removal of a cervical rib.

of the scalenus anterior, which is often the constricting agent and must be released. There are, however, cases like the first herein reported, in which the cervical rib was evidently responsible for the symptoms, or like the patient (Case 3) for whom transsection of the scalenus anterior two years before had not afforded relief, and who definitely required an exploration of the cervical rib. For these patients the lateral approach is indicated. Neither approach is entirely adequate for the thorough performance of a complete section of the scalenus anterior *and* removal of the cervical rib. Should both these structures require attention, one must employ a combination of the two exposures.

Adson objects to a lateral incision because the forward retraction of the posterior and median scaleni may irritate the brachial plexus. He states that paralysis has actually occurred from traction on the brachial plexus, but it would seem to the author that, by gently retracting the scaleni, only slight pressure would be applied to the nerves, and certainly far less than by attempting to remove the cervical rib through the interval between the upper and lower trunks of the brachial plexus as Adson advises. In the author's own experience, which admittedly thus far is too limited to be authoritative, the retraction of the scaleni has been possible by very gentle force, and has caused no nerve damage. Actually, in the lateral approach it is not necessary to expose

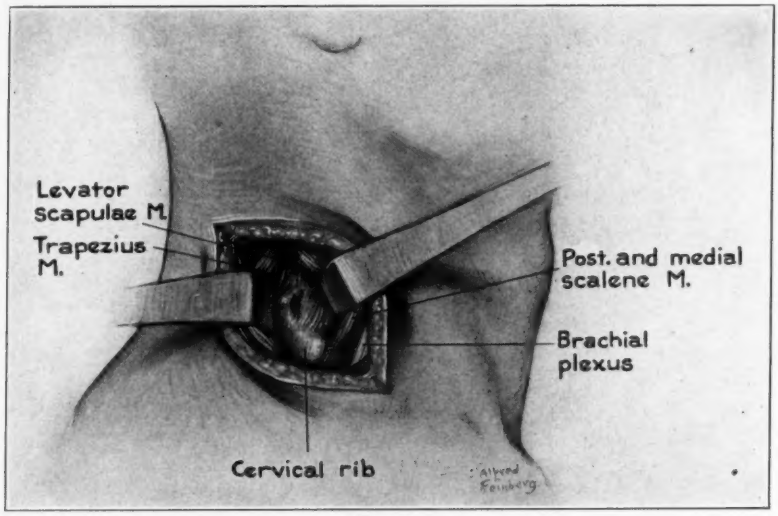

FIG. 4

In this drawing is outlined the intermuscular location of the cervical rib. The interval between the levator scapulae and the scalenus posterior must be identified. The levator is retracted backward and the scaleni forward, exposing the cervical rib in the interval between them.

any of the nerve trunks of the brachial plexus. And even if the upper cord or all of the cords of the plexus are exposed, they are seen so plainly that manipulation of them can be practically atraumatic. On the other hand, in the anterior approach for the removal of the rib one must expose not only the brachial plexus, but many other important structures, necessarily involving extensive handling or instrumentation of all of them.

CASE REPORTS

CASE 1. R. T., female, aged fifteen years, applied at the Clinic at the Hospital for Joint Diseases for treatment of a tumor on the right side of her neck. The examination revealed a mass, the size of a pigeon's egg, directly behind the clavicular portion of the sternomastoid muscle. The roentgenogram revealed bilateral cervical ribs arising from the seventh cervical vertebra. The rib on the right side was much larger than that on the left side, which accounted for the appearance of a tumor.

An operation was performed through an oblique four-inch incision on the lateral aspect of the neck. The cervical rib was exposed in the interval between the levator scapulae and the scalenus posterior. The cervical rib was found to articulate with the first true rib. The anterior extremity of the cervical rib was occupied by an osteochondroma. The cervical rib was osteotomized near its vertebral origin; was lifted up and freed from the adjacent tissues by dull dissection; and removed by disarticulating it from the first rib. Healing took place by primary union; there were no complications, and the patient was relieved of a conspicuous mass in the neck.

CASE 2. Mrs. L. G., forty-two years old, was referred to the author for persistent and increasing pain in the right arm, pain in the right side of the neck, and numbness of the small and ring fingers on the same side. The symptoms had appeared several months previously without any known cause. The examination revealed bilateral cervical ribs of approximately equal size. Up to this time she had not had any symptoms on the left side. She had had some conservative treatment before consult-

ing the author, who continued the conservative treatment for several weeks without any relief. She was, therefore, admitted to the Hospital for Joint Diseases for removal of the right cervical rib.

The operation was performed through a three-inch oblique incision over the lateral aspect of the right side of the neck at the level of the seventh cervical vertebra. The rib was easily exposed by the intermuscular route described in the consideration of the technique. The rib consisted of a large hornlike process from the tip of which extended a strong aponeurotic band, one-quarter inch wide, which extended downward and was attached to the first rib. When the band was cut, there was an immediate release of the first rib, and the whole shoulder seemed to drop down. The cervical rib was osteotomized at its base and readily removed. The pain in the neck and right arm persisted for several weeks, but ultimately was completely relieved, and the patient returned to her occupation, as a stenographer.

CASE 3. Mrs. M. O., twenty-four years old, was referred for persistent severe pain in the right arm, which was relieved only when the patient remained in bed supporting her arm in a sling. She had had the symptoms for a number of years. Two years previously she had had an operation on the right side of her neck by an eminent surgeon who, in the absence of roentgenographic evidence of a cervical rib, diagnosed the condition as a scalenus anterior syndrome. At operation he found a greatly thickened and hypertrophied scalenus anterior which he sectioned. The symptoms, however, were not relieved. Consequently when the author saw this patient, he decided that the etiological basis for the continuation of the symptoms was an aponeurotic band, extending between the right transverse process of the seventh cervical vertebra and the right first rib, and causing pressure upon and irritation of the brachial plexus.

At operation the right transverse process of the seventh cervical rib was exposed in the manner already described. A small, narrow, but tight, fascial band extending from the transverse process down into the neck was found. The transverse process and the fascial band were easily removed. The brachial plexus was explored for possible adventitious bands pressing upon it, but none were found. The symptoms persisted for several weeks after the operation, but gradually faded out so that the patient was able to resume a normal, active life.

SUMMARY

The author does not intend to minimize the importance of the anterior approach when the essential element in the operation is the release of the scalenus anterior. It is, perhaps, needless to emphasize, that in undertaking the sectioning of the scalenus anterior, the surgeon must be continuously on his guard not to injure the many important structures lying underneath the sternomastoid muscle. Donald and Morton call attention to a patient operated upon through an anterior approach in whom the thoracic duct was lacerated. They quote Spurling and Bradford, who commented on the occurrence of temporary paralysis of the diaphragm following traction on the phrenic nerve which is in intimate relation with the scalenus anterior. In the lateral approach no such important structures are encountered. The author is not here entering a plea for the exclusive use of the lateral approach in cases with symptoms of the scalenus anterior syndrome, but wishes only to direct attention to the fact that, when it is primarily desired to remove a cervical rib or the band of connective tissue extending downward from it, the lateral approach offers a simple and safe method for its performance, and has the following distinct advantages:

1. Accessibility to the rib in the intermuscular region between the levator scapulae posteriorly and the scaleni anteriorly.

2. The entire rib can be removed by freeing its proximal extremity and elevating it from behind forward from the adjacent muscles.

3. The aponeurotic or fascial band extending downward from the tip of the rib, which itself often causes pressure on the brachial plexus and subclavian artery, can be severed, and its pressure effect removed.

4. The approach is avascular, since no important vessels are encountered.

5. There is little danger of damaging the brachial plexus and subclavian vessels because they are protected by retraction of the scaleni.

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GRADATION OF EWING'S TUMOR (ENDOTHELIAL MYELOMA) *

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The available literature contains no record of an attempt to grade Ewing's tumor, so a serious study has been made of thirty patients, particularly with reference to microscopic findings of the tumors, in an effort to find reliable data which would aid in grading the malignancy of this entity. These thirty patients were selected from a total of forty-two with similar tumors; the others were rejected because of insufficient data for the present purposes. This must be regarded purely as a preliminary investigation. Obviously, moreover, a study of this kind, regardless of how painstaking, is fraught with many pitfalls and personal-equation errors.

HISTORY OF GRADING MALIGNANCIES

To Broders [2] must be given the credit for introducing and popularizing the method of grading malignant neoplasms. In 1920, he published an analysis of 537 cases of carcinoma graded by the figures 1, 2, 3, and 4 to indicate the degree of malignancy, from the lowest to the highest. Among other things, he based the degree of malignancy upon the proportion of differentiated and undifferentiated tumor tissue, the number of cells with large nucleoli (so-called "one-eyed" cells), and mitoses. The Broders system of grading carcinoma is now generally accepted as being of definite prognostic value.

The grading of sarcoma has been attempted only within the past few years. Meyerding, Broders, and Hargrave[3,15] have published two papers dealing with the grading of soft-tissue sarcoma. They have divided these tumors into the following three types: (1) fibrous, (2) fibrocellular, and (3) cellular. This division was predicated upon the histopathology,—that is, (1) the extent of fibrogenesis, (2) the relative proportion of fibers and cells, and (3) the amount of differentiation of the cells.

ORIGIN OF EWING'S TUMOR

That endothelium is derived from the mesoderm [1] no one will question, though embryologists and histo-anatomists are undecided as to the composition of the mesoderm. Opinion is divided as to whether it is composed of a part of the ectoderm, or entoderm, or of both. The majority of observers favor the latter theory. If this be true, there is little wonder that the occasional Ewing's tumor, which portrays organoid or histoid qualities,

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† Deceased.

may confuse even the most experienced observer as to whether it is atypical carcinoma or atypical sarcoma. Zeit, from a study of the morphological and histogenic characteristics of endothelial tumors, concluded that the cells were of a type intermediate between epithelial and connective-tissue cells.

The exact origin of Ewing's sarcoma, therefore, is still unsettled; what is known regarding its histogenesis is based on conjecture. In a previous article [11], one of the authors called attention to the different opinions which have been proposed by Melnick, Oberling, Connor, Ewing, Geschickter and Copeland, Kolodny, Colville and Willis, and Hirsch and Ryerson. The authors regard the tumor as of subperiosteal or intracortical perivascular endothelial origin, even though postmortem findings in one of their patients [5] revealed the left suprarenal gland involved by the tumor. They believe the tumor in the suprarenal gland was not a primary growth, unless this neoplasm is characterized by multiple primary origins. Further discussion of this topic is not apropos to the title of this paper.

The present study has been approached from a broad point of view, in an attempt to correlate the clinical findings, both subjective and objective, the roentgenographic evidence, and the therapeutic results with detailed microscopic data.

CLINICAL FINDINGS

Pain was the most constant single clinical finding in the thirty patients. Almost every one suffered at one time or another with pain of a boring or throbbing character, which was usually worse at night. All reported freedom from pain at intervals. As to the presence of fever and leukocytosis, which are believed to be commonly associated with Ewing's tumor at some time during its course, the records were not sufficiently complete for statistical purposes. The palpation of a tumor was not always possible because of overlying soft-tissue structures, or because of its location in an inaccessible region. Locally, the condition of the skin, circulation, and temperature were of little diagnostic value.

Of the series of thirty patients, nineteen gave a history of symptoms for a period of one year or less prior to admission. Only two of these are alive: one (Case 1) reported symptoms of twelve months' duration, and the other (Case 6) gave a history of symptoms of four months' duration. The latter had three biopsies and was given roentgen therapy and Coley's toxin, but did not have an amputation. Of those with symptoms from two to four years before admission (ten patients), two are living (Cases 26 and 28). One patient was excluded because no definite record of the duration of his symptoms was available (Case 18).

The average "tumor life" of the seventeen patients with symptoms of one year or less on admission was one year and five months, while for the eight patients with symptoms of more than one year's duration, the average tumor life was five years and seven months. What significance,

if any, may be placed in the fact that those with symptoms of two years or more before admission lived an average of four times as long as the group with symptoms of one year or less, we are not prepared to state definitely. Rather than attribute any significance to the longer duration of symptoms as having, of itself, anything to do with the longer average tumor life, we would prefer to call attention to the possibility that the higher average mitotic-figure count—7.2 in the first group, with a short history, as compared to a count of 6.3 in the second group, with a longer history—is the important factor in the resultant disproportion of length of tumor life of the two groups of approximately four to one. There were eight, or 42 per cent., of nineteen patients in the group with the shorter preadmission clinical course, with nine or more mitotic figures, against two, or 20 per cent., of ten patients in the group with a longer preadmission course. The duration of symptoms and mitotic-figure count may be interrelated and even interdependent; a long tumor history may be associated with diminished cellular activity.

SITE OF PRIMARY TUMOR

In two (Cases 1 and 6) of the four living patients, the primary tumor was in the tibia, while in the other two, the tumors were in the femur and ulna respectively (Cases 26 and 28). The average tumor life of the nine patients with the primary tumor either in the pelvic bones, ribs, or vertebrae was two years and one month whereas the tumor life of those with a lesion of the extremities (fifteen patients) was three years and four months. Thus, as a rule, those patients with a lesion in the torso lived a much shorter time than those with a tumor in the extremities. Whether the anatomical site or the type of treatment each group received, or both, was responsible for this disproportion in the length of tumor life cannot be definitely stated. The tumors of the torso had an average mitotic-figure count of seven and four-tenths as compared to an average count of six and four-tenths in those of the extremities.

ROENTGENOGRAPHIC FINDINGS

Condensation, as revealed by roentgenograms, is the earliest bone manifestation of Ewing's tumor, being especially apparent in young patients. In a previous publication, one of the authors [4] called attention to three stages of osseous change presented by the tumor in the roentgenograms, as follows: "(1) condensation of the shaft of the bone without reaction of the periosteum . . .*; (2) the typical invasion with expansion, striation, and destruction of the cortex, and reactive bone production of the periosteum in layers (onion peel) . . . ; (3) disintegration of the periosteal layers and shaft with extension of the tumor to surrounding parts. The remains of the periosteum are apparent by marked lipping near the junction of the normal shaft and the tumor". It occurred to the authors,

* This stage, unfortunately, is observed rarely as most cases are not seen at so early a period . . .

therefore, to compare roentgenograms of patients seen early with those of patients seen after real bone destruction had taken place, to determine whether these observations would reflect in any way the degree of malignancy. Six patients, five of whom are dead, were first seen during the stage of condensation only of the bone, and twenty-three, twenty-one of whom are dead, were observed after bone destruction had taken place. The average duration of symptoms before admission in the five of the former group was ten months, as compared to a life of eleven months after admission and the institution of radical treatment. In the group of twenty-one patients, the average duration of symptoms before admission was one year and four months, as compared to an average life of one year and seven months after admission. The tumor-life average in the first group was one year and nine months, whereas in the second group it was two years and eleven months. The average mitotic-figure count was eight and two-tenths in the first group, as compared to seven in the second group. This is believed to be of prognostic significance.

The above observation seems to contradict previous teachings insofar as it relates to Ewing's tumor,—that is, that the sooner a diagnosis is made and radical treatment applied, the better will be the prognosis. According to the authors' observations, therefore, if a patient is seen with the earliest roentgenographic osseous reaction to the tumor—namely, condensation—a more guarded prognosis should be made than if he is seen later, after bone destruction has taken place. This would seem to lend support to recent deductions made by Ferguson from a study of 400 cases of osteogenic sarcoma gathered from the Registry of Bone Sarcoma of the American College of Surgeons, to the effect that if a patient is seen in the early course of the disease (first six months) and treated conservatively (with roentgenotherapy, for example), a better prognosis may be given than if radical treatment, such as amputation, has been instituted. Ferguson concluded that the factor of time influences the prognosis. It is likely, however, that the real factor in this apparent paradox is the cellular activity as measured by the mitotic-figure count.

TREATMENT

The treatment of the authors' patients included amputation for fifteen patients, or 50 per cent.; resection for two patients, or 6.6 per cent. (Cases 13 and 16); roentgen therapy for twenty-six patients, or 86.7 per cent.; and Coley's toxin for eight patients, or 26.7 per cent. (Cases 6, 8, 10, 11, 13, 16, 21, and 28). The four (13.3 per cent.) living patients (Cases 1, 6, 26, and 28) were treated as follows: Case 1, A. L. M., amputation, alive fourteen years after onset of symptoms; Case 6, J. O. T., roentgenotherapy and Coley's toxin, alive ten years and nine months; Case 26, M. H., radium, roentgenotherapy, and amputation, alive five years and six months; and Case 28, B. C., roentgenotherapy and Coley's toxin, alive three years and six months. The authors wish to emphasize the fact that the tumors of all but one of the four living patients fell in the group with

the lowest mitotic-figure count—one to five per high-power field—and that in the fourth the count of the tumor was only six.

MICROSCOPIC FINDINGS

Type of Growth

Endothelial myeloma grows, for the most part, in solid sheets of polyhedral cells whose nuclei are more or less uniform in size. There is no intercellular stroma, and the cells are either completely differentiated or totally undifferentiated. The cytoplasm is faintly stained or invisible. Except for a difference in the shapes of the cells, the cellular type of soft-tissue sarcoma presents a similar picture. Because of the relative lack of pleomorphism and the high mortality rate, it is the opinion of the authors that the cells of Ewing's tumor are undifferentiated; therefore, to this one quality a malignancy rating of Grade 4 should be ascribed.

The presence of many or few oat-cell or spindle-shaped nuclei in a section does not seem to influence the grade of malignancy. Frequently, however, it confuses the pathologist in making a diagnosis of the tumor. Of the two patients who have lived longest (Cases 1 and 6), one had no spindle-shaped nuclei, while the other had a large number.

As hyperchromatism of the nucleus is a feature of other malignant tumors, so also it is of endothelial myeloma. One or more "chromatin knots" or masses were observed in microscopic sections of all the tumors in this series. In an attempt to determine whether any significance could be attached to these chromatin knots, tissue sections of all thirty tumors were studied and grouped from 1 to 4, according to the relative amount of chromatin material which they contained. Ten of the thirty tumors were placed in Group 4. All these patients are dead, their average tumor life having been three years and four months. In contrast, only three tumors were in Group 1. One of these patients is still living and the average tumor life of the other two was four years and three months. According to this grouping by nuclear chromatin knots none of the patients in Groups 3 and 4, comprising a total of eighteen, is living. One patient in Group 1 (Case 1) is living fourteen years after the onset of symptoms, and three patients in group 2 (Cases 6, 26, and 28) are living, ten years and nine months, five years and six months, and three years and six months, respectively. The value of these observations is doubtful, although it would appear that those tumors showing a heavy chromatin content may be considered more malignant.

A microscopic study was made to determine what prognostic significance, if any, could be attached to tumor cells with and without nucleoli. Of the thirty tumors analyzed, fifteen revealed no such finding, while fifteen were found to contain nucleoli. This feature is probably of little, if any, significance in determining the degree of malignancy. No nucleoli were found, however, in the tumors of three of the four living patients (Cases 1, 6, and 28).

Mitotic Cell Activity

That mitosis is an evidence of cellular growth activity is recognized by all pathologists. A given number of mitotic figures per microscopic high-power field will indicate, in a measure, at least, the relative degree of cell activity in a tumor. In addition, the sizes and forms of the mitotic figures is thought to express to some extent the malignant proclivities of a tumor. Atypical, bizarre-shaped mitotic figures were seen in practically all of the tumors. The series were studied with the foregoing ideas in mind, and the tumors were divided into three grades, according to the number of mitotic figures per high-power field. There were fourteen tumors in Grade 1, with from one to five mitotic figures; nine in Grade 2, with from six to ten figures; and seven in Grade 3, with from eleven to fifteen figures.

Of the thirty patients, four (Cases 1, 6, 26, and 28) are living, fourteen years, ten years and nine months, five years and six months, three years and six months, respectively. The other twenty-six patients died of metastases. The tumors of the first two and the fourth living patients were of Grade 1, while that of the third fell in Grade 2. The family physician * of the latter patient recently informed the authors that there was no evidence of recurrence of the tumor, five years and six months after the onset of symptoms.

The average length of tumor life of the patients with Grade 1 tumors was three years and nine months, excluding Case 18; the longest was eleven years (Case 8); and the shortest was eleven months (Case 3). Two patients (Cases 8 and 13) lived eleven years and five years and seven months, respectively. Excluding those living over five years (Cases 1, 6, 8, and 13), the average tumor life was two years; the longest three years and six months (Case 28), and the shortest eleven months (Case 3).

The eight patients with tumors in Grade 2 had an average tumor life of three years and nine months. The longest was nine years and six months (Case 11), and the shortest one year and five months (Case 12). If all the patients who lived over five years were excluded (Cases 11, 16, and 26), the average tumor life of the remaining six would be two years and five months; the longest, three years and eight months (Case 22), and the shortest, one year and five months (Case 12).

The average tumor life of the seven patients with tumors in Grade 3, having eleven or more mitotic figures per high-power field, was one year and six months; the longest was two years and ten months (Case 23), and the shortest was eight months (Case 27). All the patients with tumors in this grade are dead.

The difference of approximately two to one in the length of life from the onset to death between patients with Grade 1 tumors, exclusive of those who are living, and the patients with Grade 3 tumors is obvious, whereas, if the living patients are included in Group 1, the difference increases to approximately three to one. The difference in the length of

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life of the patients with Grades 1 and 2 tumors is less striking. This is explained by the fact that in four, or 44 per cent. (Cases 11, 12, 17, and 26) of the nine tumors in Grade 2, the mitotic-figure count was only six, which would place these four on the border line between the two groups. One of the four patients (Case 11) lived nine years six months after the onset of symptoms.

Although from this microscopic data one cannot state that a patient will live a certain period merely because of a mitotic-figure count of five or less, one can state that such a patient's life expectancy is two to one better than that of a patient with a mitotic-figure count above ten.

SUMMARY AND CONCLUSIONS

The grading of Ewing's tumor, as of carcinoma and sarcoma, is exceedingly difficult. A number of factors make this so, among them, and most conspicuous in this study, is the total lack of differentiation of the tumor cell. This being true, the prognosis should always be guarded.

In order to discover, if possible, some criteria for estimating the degree of malignancy of Ewing's tumor, we have made a study of thirty cases from the standpoint of clinical findings, roentgenograms, therapeutic results, and microscopic features. The nuclear chromatin content, and the cell activity as measured by the number of mitotic figures per high-power field, seem to be the most significant of our findings. A classification of the tumors according to their chromatin content indicates that those containing a large number of chromatin knots are probably more malignant than those containing a lesser number.

In studying the cellular activity, the tumors were divided into three grades, according to the number of mitotic figures in a high-power field, as follows: Grade 1, one to five figures; Grade 2, six to ten figures; and Grade 3, eleven to fifteen figures. It would appear that a patient with a tumor having five or less mitotic figures (Grade 1) has approximately a 23-per-cent. chance to survive ten years and a 31-per-cent. chance to live five years, whereas, if the mitotic-figure count is eleven or above (Grade 3), he will probably live little over one year. None of the patients with tumors in Grade 2 of this series lived ten years, and three, or 33 per cent., lived over five years, one of whom is alive five years and six months after the onset of symptoms.

The roentgenographic evidence presented by these thirty cases indicates that the early stage, characterized by bone condensation, goes hand in hand with increased cellular activity, whereas late bone changes are usually accompanied by diminished cellular activity.

This group of cases is obviously too small from which to draw any definite conclusions regarding the gradation of Ewing's tumor. The authors propose, however, to continue their studies and trust that others will carry out similar investigations. Studies of large numbers of cases might throw more light upon this subject and lead to the discovery of a method of establishing a more accurate prognosis.

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SCOLIOSIS COMPLICATED BY SPINAL-CORD INVOLVEMENT

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Scoliosis complicated by cord involvement is an unusual condition, as a review of the literature indicates. The seven cases to be presented in this clinical review were selected from a series of 2,000 cases of scoliosis of all types, excluding those of a traumatic or inflammatory nature directly or indirectly related to the spine. Mauclaire, in 1913, first described the clinical picture of cord involvement due to scoliosis. Ridlon in 1916, Steindler in 1929, and Viets and Clifford in 1932, also described this clinical entity.

There appears to be no consistency as to the age of the patient at the onset of the neurological manifestations. The youngest patient in this series was six years of age, and the oldest was twenty-one. The average age of incidence was fifteen years. Although it is not an exact rule, the usual time of occurrence of neurological signs is during adolescence and the period of rapid growth[1].

In this series of seven cases, three were associated with rachitic scoliosis, three with congenital scoliosis, and one of doubtful etiology was associated with neurofibromatosis (von Recklinghausen's disease). In no instance was cord involvement observed in the paralytic or habitual type of scoliosis.

In each instance the scoliosis was of a severe type, with the exception of one case which was considered moderate. This moderate case, however, was associated with a kyphosis. The paralytic signs developed regardless of the direction of the primary curve. It was observed, however, that all the primary curves involved the high thoracic or cervicothoracic area. Roentgenograms revealed that the primary curve was one with a sharp angulation. There were two right thoracic; one right thoracic, left lumbar; one left cervicothoracic, right thoracic; one left cervicothoracic, right lumbar; one right thoracolumbar; and one left thoracic, right lumbar.

The apex of the primary curve in three cases was found to be at the level of the seventh thoracic, in two at the tenth thoracic, and in two at the fourth thoracic vertebra. There appears to be a definite relation between the level of the apex and the rapidity of development of the neurological signs. The three patients with the apex of the curve at or above the level of the seventh thoracic vertebra showed rapid progress of the clinical signs (Cases 4, L. S.; 6, M. L.; and 7, C. N.).

The paralysis developed in spite of what seemed to be adequate

* Service of Arthur Steindler, M.D.

conservative support and treatment. The treatment of the scoliosis in the preparalytic state consisted of exercises, braces, corrective casts, and traction on the torso. One case of paralysis developed during the period while the patient was undergoing traction.

The paralysis progressed rapidly in three cases, slowly in three, and remained stationary in one case. The patients who had a rapid progression of clinical signs and symptoms were those previously mentioned as having high curves of a severe nature.

Six of the seven patients had both sensory and motor changes. The motor involvement was typical of an upper motor-neuron lesion with spasticity. One patient had only a sensory disturbance but had a laminectomy five months after the onset of the sensory signs.

In three patients the motor signs appeared first and the sensory disturbance followed; in four the sensory manifestations were noted before the motor signs.

Trophic changes appeared in only one patient, in the form of a trophic ulcer over the buttocks. Sympathetic involvement was recorded in only one case prior to operations, and this involvement was of the bladder. Of the seven patients, only two had symmetrical manifestations,—six were involved bilaterally, and one unilaterally.

No single series of cases or collective review seems large enough to establish any uniform method of treatment to fit every case of cord involvement due to scoliosis. It is impossible to state from roentgenographic examination whether or not there is a direct encroachment on the cord by the osseous portion of the spine. It is definitely known that the signs and symptoms will clear up under conservative treatment (Case 5, LaV. F.), but will shortly recur unless under strict observation with adequate immobilization.

Six of the patients in this series had an adequate trial of conservative treatment; the one with only sensory changes was laminectomized early. Only two patients showed improvement under traction,—in one the improvement was considerable. The improvement in both was temporary, however, and there was a return of the neurological manifestations.

Spinal fusion gives no assurance of arresting the progress of the symptoms and signs. One patient (Case 1, B. K.) had a fusion operation by the combined method of Steindler[5], and there was an increase in the neurological manifestations in spite of a solid bony fusion of adequate length. The neurological signs slowly progressed over a period of four years, at which time the patient reached the end of her growing period[6].

Once the condition has been observed and a complete or partial block is believed present, laminectomy seems to be the method of choice. The literature offers ten cases in which laminectomy was performed.

Five of the authors' patients were treated by laminectomy and four showed definite improvement,—the one (Case 3, S. R. S.) showing no improvement died three years postoperatively of pneumonia. An autopsy was not allowed. The results of the operative procedures are

taken up in detail in the case histories and neurological charts. The results of laminectomy were considered good when the patient showed a complete or nearly complete restoration of his motor status, and at least partial recovery of his sensory status. The only sequelae in the patients in whom the results were considered as good were a small patch of impairment of superficial sensation and a slight motor weakness of the lower extremities, noted after strenuous or prolonged exercise. The findings at the time of the laminectomy were torsion of the cord in four cases, and direct pressure on the cord in only one. The direct pressure was from a bone ledge and not from direct

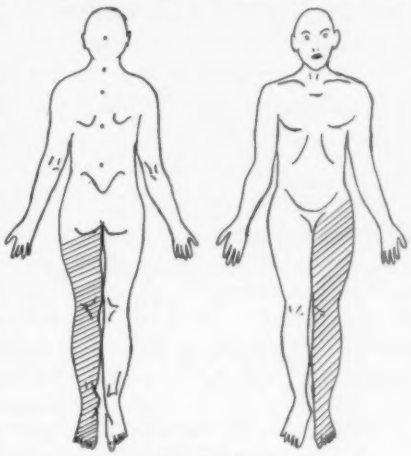

FIG. 1-A

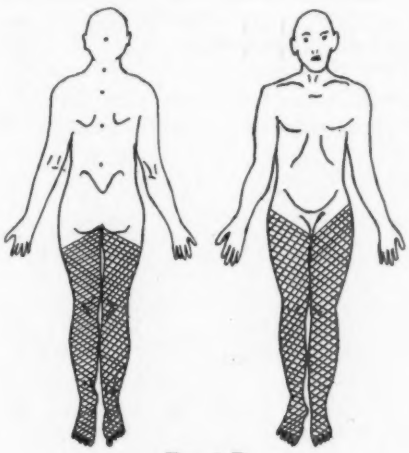

FIG. 1-B

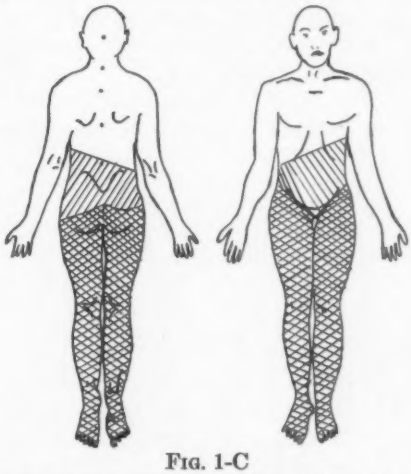

FIG. 1-C

Fig. 1-A: Case 1. B. K. (C-3656), October 29, 1929, aged six, was admitted with a moderately severe right thoracic, left lumbar curve, nineteen months before fusion. The motor signs had appeared prior to the sensory.

Hatching shows area of diminished sensation to pain, cotton, and temperature.

Gait: There was slight weakness and spasticity of the left leg.

Reflexes: Increase in knee jerk and Achilles tendon; no ankle clonus or Babinski.

Fig. 1-B: Case 1. B. K. (C-3656), January 17, 1933, twenty months after fusion.

Cross hatching shows sensation to pain, diminished; to cotton, 50 per cent.; to temperature, absent.

Gait: There was increased spasticity and generalized muscle weakness of both legs.

Reflexes: Bilateral knee jerk +++; bilateral Achilles tendon +++; bilateral ankle clonus.

Fig. 1-C: Case 1. B. K. (C-3656), May 1, 1935, four years after fusion.

Hatching shows area of diminished sensation to cotton; and cross hatching, area of anaesthesia.

Gait: There was spasticity and generalized muscle weakness of both legs. Patient wore short leg braces and used crutches.

Reflexes: Bilateral knee jerk ++++; Achilles tendon ++++; ankle clonus; Babinski.

compression by the vertebra. The dura was opened in all cases, and in four there was no evidence of a total block. In all patients on whom a laminectomy was performed, the possibility of cord tumor had been considered.

In two patients who had exploratory operations eighteen months and fourteen months following laminectomy, it was found that the defect was filled in with tough fibrous tissue. Intermingled in this tough fibrous tissue there were many bone spicules, but there was no actual bony closure of the laminal defect. The combination of fibrous tissue and islands of bone within this tissue made it necessary to use rongeurs in reopening the laminal space.

CASE REPORTS

CASE 1. B. K. (C-3656), aged six years, was admitted with a right thoracic, left lumbar curve which had been noticed eighteen months before admission. Although the history was not adequate, it was believed to be a congenital curve. For six months before entrance the curve had been increasing rapidly.

Physical examination revealed a moderately severe right thoracic, left lumbar scoliosis which was in the compensated position. There was a suggestion of weakness and spasticity of the left leg with an increase in the patellar and the Achilles tendon reflexes. Babinski and ankle clonus were absent. There were diminished sensations of the left lower extremity (Fig. 1-A).

The treatment was conservative and expectant over a period of one year. In spite of what seemed adequate support, an increase in the curvature was noticed, the spasticity

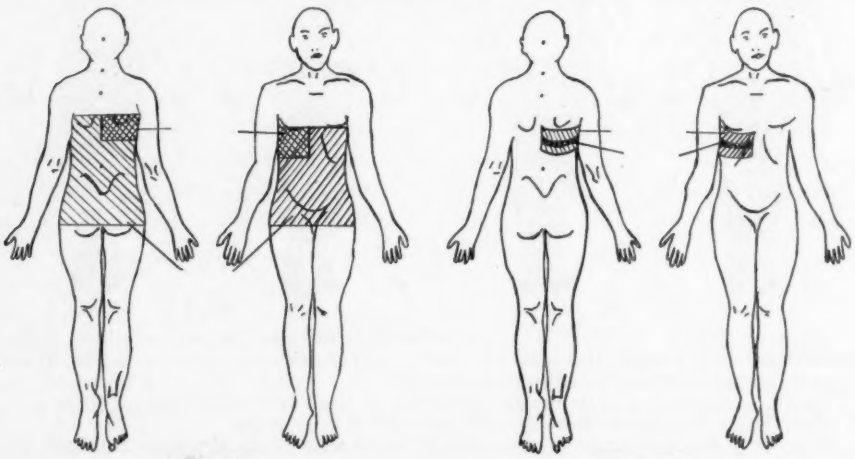

FIG. 2-A FIG. 2-B

Fig. 2-A: Case 2. H. C. (38/10918), May 16, 1936, aged fourteen, eighteen days before operation, had a moderately severe left thoracic scoliosis. The sensory signs had appeared prior to the motor signs.
Hatching shows area of diminished sensation; and cross hatching, loss of sensation.
Gait: There was spasticity in the left leg.
Reflexes: Knee jerk +++.
Spinal fluid: Pressure six millimeters of mercury; no rise on jugular pressure; globulin +++; lymphocytes eight per 100 cubic millimeters.

Fig. 2-B: Case 2. H. C. (38/10918), July 3, 1936, one month following operation.
Hatching shows area of diminished sensation; and cross hatching, loss of sensation.
Gait: Normal; no spasticity of the left leg.
Reflexes: Normal.

of the gait was pronounced, all reflexes of the lower extremities were exaggerated, a Babinski was present, and a sustained ankle clonus was present bilaterally.

An attempt was made to relieve the possible cord pressure by correction in a Risser jacket. Correction of the curve was satisfactory, but there was no improvement in the neurological signs. A fusion of the spine was done at this time, nineteen months after admission.

The fusion held well and there was no increase in the scoliosis. In spite of a successful fusion, the neurological signs increased (Figs. 1-B and 1-C).

CASE 2. H. C. (38/10918), aged fourteen years, was admitted May 16, 1936, with a moderately severe left thoracic scoliosis of two years' duration. The spine was extensible. On admission there was no evidence of neurological disturbances. The curvature was thought to be rachitic.

Conservative treatment was carried out until June 3, 1936, at which time the patient complained of a tingling sensation in the feet and a spastic gait of the left leg (Fig. 2-A). Laminectomy was performed on the thoracic spine from the first to the fifth thoracic vertebrae. The cord was found to be pulsating and no direct pressure could be found. There was, however, a distinct tension of the cord due to torsion. The postoperative course was uneventful.

One month after the operation there was a distinct improvement in the sensory findings; no pathological reflexes could be elicited; and the spasticity had disappeared (Fig. 2-B).

A spine fusion was performed on October 6, 1937. The soft tissues were stripped from the transverse process for a short distance laterally and the bone bed made at the junction of the transverse process with the lamina just distal to the superior articular

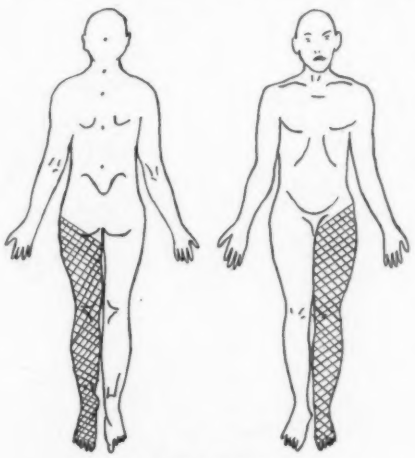

FIG. 3-A

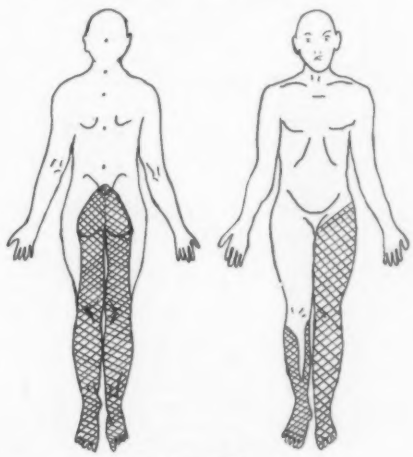

FIG. 3-B

Fig. 3-A: Case 3. S. R. S. (F-11), October 9, 1930, aged twenty-one, was admitted with the diagnosis of severe thoracolumbar kyphoscoliosis, twelve weeks before operation. Patient was unable to tell whether motor or sensory signs had appeared first. Bowel and bladder were normal.

Cross hatching shows area of anaesthesia.

Gait: There was spasticity of left leg.

Reflexes: All hyperactive; bilateral ankle clonus.

Fig. 3-B: Case 3. S. R. S. (F-11), November 30, 1932, twenty-two months after operation. There was bowel and bladder retention.

Cross hatching shows the area of anaesthesia.

Gait: There was spasticity of both legs.

Reflexes: Bilateral ankle clonus.

Patient was followed for three years, during which time there was no return of function. Patient died from pneumonia.

process. When sufficient bone bed had been developed, a tibial graft was laid on the bone bed throughout the entire region of the laminectomy on both sides of the spine. The result was good.

CASE 3. S. R. S. (F-11), an achondroplastic dwarf, aged twenty-one years, was admitted October 9, 1930, with a severe lumbar kyphoscoliosis. Nine months before admission the patient had been unable to lift the left foot off the ground, and had noticed also a disturbance of sensation.

Physical examination showed a marked thoracolumbar kyphoscoliosis, and marked spasticity of the left leg with anaesthesia (Fig. 3-A). The reflexes were hyperactive and there was bilateral ankle clonus. Bowel and bladder control were normal.

Traction on a curved frame was carried out for twelve weeks with no improvement; so, on January 25, 1931, a laminectomy was performed including the ninth to the twelfth thoracic vertebrae. There was an absence of pulsation, but no direct pressure, and a torsion of the cord was found. Immediately after the operation there was bladder retention, loss of bowel control, and an increase in the area of anaesthesia (Fig. 3-B). On opening the incision, large blood clots were found and removed. Suprapubic drainage was necessary.

The patient died three years later of pneumonia without having had any return of function.

CASE 4. L. S. (38/15458), aged sixteen years, was admitted May 27, 1936, with a diagnosis of a left thoracic scoliosis and von Recklinghausen's neurofibromatosis. The scoliosis had been recognized two and one-half years before admission, and had been increasing rapidly. On admission all reflexes of the lower extremities were exaggerated,

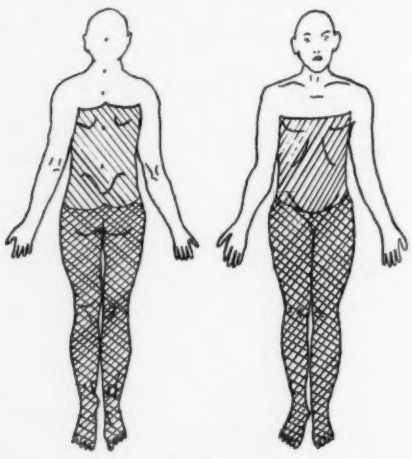

FIG. 4-A

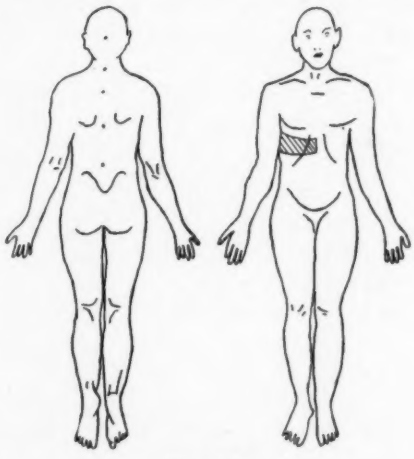

FIG. 4-B

Fig. 4-A: Case 4. L. S. (38/15458), aged sixteen, was admitted May 27, 1936, with a left thoracic scoliosis, von Recklinghausen's neurofibromatosis, and no sensory changes. The chart shows changes in sensation on June 16, 1936, five months before operation. The motor signs had appeared prior to the sensory.

Hatching shows area of diminished sensation; and cross hatching, area of anaesthesia.

Gait: There was progressive spasticity; generalized weakness of legs.

Reflexes: Exaggerated; Babinski; ankle clonus.

Spinal fluid: Sugar eighty-six milligrams per 100 cubic centimeters; protein 260 milligrams per 100 cubic centimeters; pressure eight millimeters of mercury; no increase on jugular pressure.

Fig. 4-B: Case 4. L. S. (38/15458), July 25, 1939, thirty-two months following operation. Patient wore back brace and had just started weight-bearing.

Hatching shows area of diminished sensation.

Gait: Power in the lower extremities was increasing.

a Babinski was present, and a sustained ankle clonus. There were no sensory disturbances on admission.

The patient was placed in traction and treated conservatively until June 16, 1936, when sensory changes were revealed as well as motor involvement (Fig. 4-A). Traction was continued until November 17, 1936, with no improvement in either the motor or sensory conditions.

On November 17, 1936, a laminectomy was performed from the seventh cervical to the sixth thoracic vertebrae. On exposure of the cord a definite kink was demonstrable at the level of the third and fourth thoracic vertebrae. There was pulsation of the cord, and no direct pressure was found.

Immediately after the operation there was an exaggeration of all symptoms and signs, with a loss of bowel and bladder control. Because of the persistent increase in neurological signs the wound was opened three days following the laminectomy and

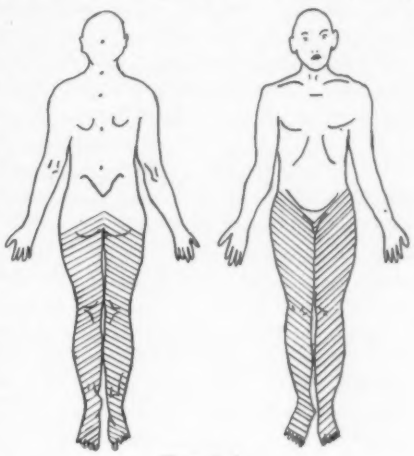

FIG. 5-A

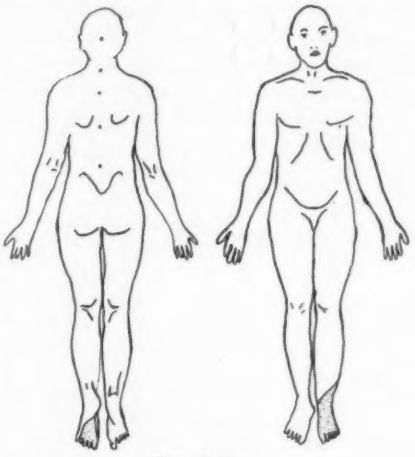

FIG. 5-B

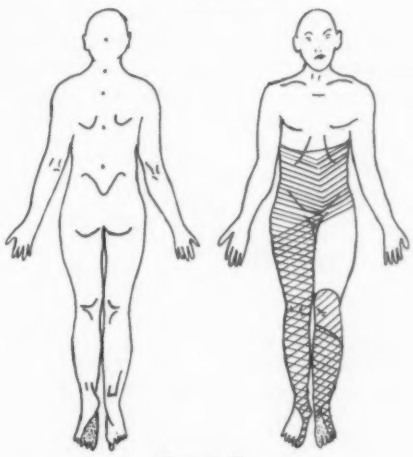

FIG. 5-C

Fig. 5-A: Case 5. LaV. F. (38/15079), February 15, 1938, aged thirty-three, twenty-six years after onset of scoliosis and six months following onset of the neurological signs, was admitted with a marked right thoracolumbar scoliosis with rotation.

Hatching shows sensation to pain, absent; to cotton, 75 per cent.; to temperature, normal.

Gait: Spastic; ataxic; general muscle weakness of legs; patient used crutches.

Reflexes: Knee jerk ++; Achilles tendon ++; ankle clonus; Babinski.

Fig. 5-B: Case 5. LaV. F. (38/15079), May 11, 1938, after three weeks of head and pelvic traction.

Stippling shows area of hyperaesthesia.

Reflexes: Same as on February 15, 1938.

Fig. 5-C: Case 5. LaV. F. (38/15079), November 13, 1939.

Hatching shows area of diminished sensation; cross hatching, area of anaesthesia; and stippling, area of hyperaesthesia.

Gait: Unable to walk.

Reflexes: Knee jerk ++++; Achilles tendon ++++; Babinski; ankle clonus; loss of position sense.

Spinal fluid: Rise on jugular pressure.

several large clots expressed. The operative site was drained with penrose tubing for twenty-four hours.

Examination on February 1, 1937, three months after operation, revealed a definite improvement in sensory and motor involvement. The bowel and bladder disturbances had cleared up. The sensory disturbance was the first to improve. Since February 1, 1937, the patient has made a slow but steady progress. There is still some weakness of the lower extremities, in greater part due to disuse; there is also a decrease in the spasticity, as well as less exaggeration of the reflexes (Fig. 4-B).

CASE 5. LaV. F. (38/15079), aged ten years, was first seen March 27, 1915, at which time he had a marked right thoracolumbar scoliosis with rotation. The condition was partially corrected and a cast was applied with the patient on the Abbott frame. He wore a scoliosis brace until 1923. The patient was lost to the Clinic for five years and became considerably worse. In January 1928, he revealed hyperactive reflexes and a positive Babinski. Traction on a curved frame relieved his symptoms and he was allowed to be ambulatory in a brace. He was again lost to the Clinic until February 1938, at which time the scoliosis had increased and the neurological signs revealed cord involvement (Fig. 5-A). The patient was placed in traction and showed marked improvement (Fig. 5-B). He was then allowed to return home on condition that traction be maintained. The traction was not carried out and he again became progressively worse, until walking became an impossibility (Fig. 5-C). Laminectomy was not performed because of his poor physical condition. The spine is still uncompensated.

CASE 6. M. L. (4522), aged seventeen years, was admitted March 27, 1920, with a scoliosis, which had been noticed two years prior to admission and had been slowly increasing in severity. Patient also had had occasional numbness of the legs, more pronounced three weeks before admission. There was no history of injury to the back.

Examination revealed a moderately severe right thoracic curve with wedging of the

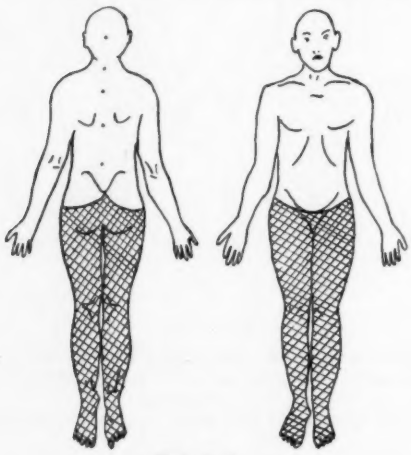

FIG. 6-A

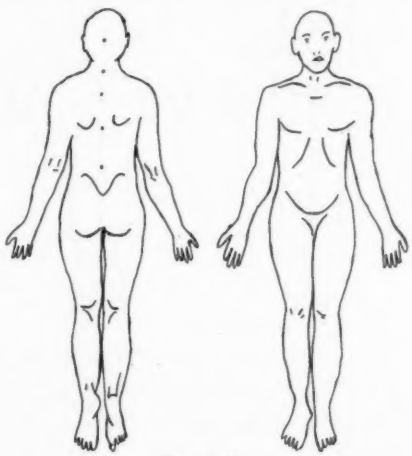

FIG. 6-B

Fig. 6-A: Case 6. M. L. (4522), March 27, 1920, aged seventeen, four months before operation, had a moderately severe right thoracic curve with wedging of the fifth thoracic vertebra. Sensory signs had appeared prior to motor.

Cross hatching shows area of anaesthesia.

Gait: There was spasticity, with muscle weakness.

Reflexes: Knee jerk ++++; Achilles tendon ++++; bilateral Babinski; bilateral ankle clonus.

Spinal fluid: Cloudy; fourteen cells per cubic millimeter; protein increased.

Fig. 6-B: Case 6. M. L. (4522), September 13, 1921, fourteen months following operation. There was no evidence of sensory disturbance.

Gait: Normal; no spasticity.

Reflexes: Knee jerk ++; Achilles tendon ++; no Babinski or ankle clonus.

fifth thoracic vertebra. All reflexes of the lower extremities were exaggerated, and there was a bilateral sustained ankle clonus. The disturbance of sensation involved both lower extremities to the anterior superior spines (Fig. 6-A). The case was considered to be a congenital scoliosis with cord involvement.

Treatment consisted of bed rest on a frame with head and pelvic traction. The patient showed very slight improvement under this treatment, which was interrupted because of diphtheria. Four months following admission a laminectomy was performed from the third to the seventh thoracic vertebrae inclusive. There was a distinct kink in the cord observed at the level of the fifth thoracic vertebra. No distinct pressure could be found on passing a probe up and down the neural canal.

After laminectomy there was a rapid improvement, and three months following operation there was a complete recovery from the disturbance in sensation. Fourteen months following laminectomy the patient had no evidence of sensory or motor disturbance, the ankle clonus had disappeared bilaterally, and there was a marked decrease in the previously exaggerated reflexes (Fig. 6-B).

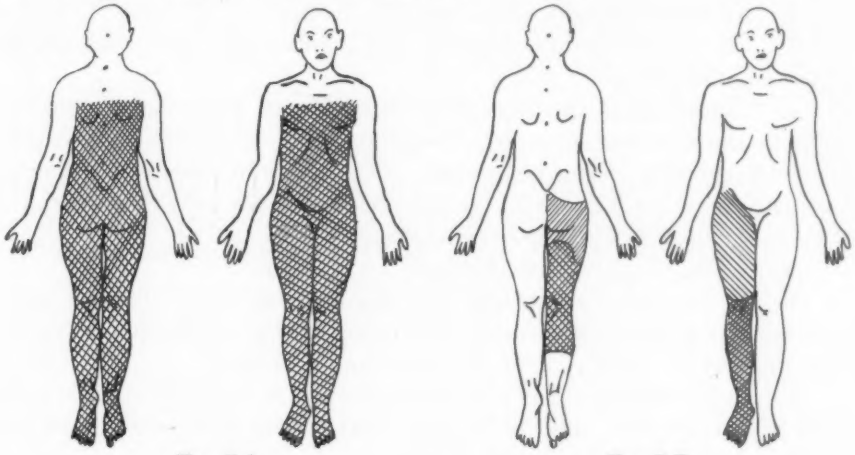

FIG. 7-A FIG. 7-B

Fig. 7-A: Case 7. C. N. (B-9331), November 16, 1927, aged sixteen years, two days before laminectomy, had a left cervicothoracic and right thoracolumbar scoliosis. The motor signs appeared prior to the sensory.

Cross hatching shows area of no sensation to temperature, cotton, and pain.

Gait: Unable to walk; spastic.

Reflexes: Knee jerk ++++; Achilles tendon ++++; bilateral Babinski; bilateral ankle clonus.

Fig. 7-B: Case 7. C. N. (B-9331), December 31, 1927, six weeks following operation. Hatching shows area of diminished sensation; cross hatching, area of anaesthesia.

Gait: Able to walk, but with moderate spasticity of right leg.

Reflexes: Knee jerk ++; Achilles tendon ++; plantar absent, no Babinski; ankle clonus not sustained.

CASE 7. C. N. (B-9331), aged sixteen years, was admitted October 21, 1927, with a diagnosis of a left cervicothoracic, right thoracolumbar scoliosis. Because of the wedging of the vertebrae in the cervical spine, the scoliosis was believed to be congenital. The patient's chief complaint was a progressive stiffness of both legs, and the inability to walk. The signs had increased rapidly during the five months prior to entrance. There was a fine fibrillation of the muscles of both legs. The sensory disturbance extended well up on the thorax (Fig. 7-A).

The patient was placed in extension with head and pelvic traction for three weeks, with no change in the neurological signs. A laminectomy was done November 18, 1927, starting at the fourth cervical and ending at the fifth thoracic vertebra. There was no pulsation of the cord below the third thoracic vertebra. There was compression of the

cord at the apex of the cervicothoracic scoliosis. Immediately following the laminectomy, pulsation was noted. Immediately following the operation, there was a loss of bowel and bladder control, which gradually returned to normal.

Patient was discharged February 26, 1928, at which time there was considerable improvement in the sensory disturbance, and bowel and bladder control were normal. The patient started to regain use of the lower extremities one and one-half months following the laminectomy. On July 26, 1930, the patient was walking unaided with only a slight spasticity of the right leg (Fig. 7-B).

CONCLUSIONS

In spite of the brevity of this series of cases of scoliosis complicated by spinal-cord involvement, the following conclusions seem justifiable and are in accord with the literature.

1. The level of the apex of the curve shows no correlation with the distribution of the neurological changes.

2. All motor changes are of the spastic type.

3. There is no definite sequence in the appearance of the sensory or motor manifestations.

4. Conservative therapy shows little, if any, permanent improvement in the neurological status; therefore, laminectomy should be performed if a short period of conservative treatment fails to relieve the signs and symptoms present, or if the neurological signs increase,—whether the sensory or motor changes are in precedence.

5. Laminectomy incisions should be drained.

6. In this series progression of signs and symptoms following laminectomy developed in all patients, but receded after a variable period, except in Case 3. This patient did not regain function.

7. Laminectomy offers the best prognosis in cases of scoliosis with signs of compression, despite the fact that torsion and tension are the etiological factors of these signs.

8. It is desirable to combine fusion with laminectomy when the patient's condition will stand this added operative procedure. The fusion should extend from horizontal vertebra to horizontal vertebra. The combined method of Steindler [5] is a rapid procedure which has proved satisfactory. There may be an increase in the curve if solid fusion is done before the end of the period of rapid growth [6].

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HEMANGIOMA OF VERTEBRAE *

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A great number of articles dealing with hemangiomata or angiomata have appeared in the literature during the past several years. These tumors may occur in practically any tissue of the body. Indeed, when one hemangioma is found, it is not uncommon to find others in other tissues of the same individual. The widespread distribution of these lesions is not necessarily an accurate index of the frequency with which they may give rise to symptoms, for many lesions may be asymptomatic.

REVIEW OF LITERATURE

First recognition of the presence of hemangiomata in vertebrae should be credited to the pathologists of several decades ago. Virchow, in 1863, reported a case in which necropsy in an elderly woman disclosed several angiomata as large as hazelnuts in two vertebrae at a considerable distance from each other; an angioma was also found in the liver.

Claims to priority in reporting the association of paraplegia with hemangioma are conflicting. It seems that Gerhardt was the first to report this association in the case of a youth, aged seventeen years. After an illness of five years, this patient died of erysipelas of three weeks' duration. Necropsy revealed angiomata of the fifth and sixth thoracic vertebrae, and invasion of the spinal canal.

Most writers credit Perman with the first description of the roentgenographic picture of hemangioma of the vertebra. He reviewed the case of a woman, twenty-four years of age, who had paraplegia of two or three years' duration, and described the roentgenographic picture. His patient recovered motor and sensory functions after laminectomy. However, a year earlier Gold had reported a case of paraplegia in which the roentgenographic appearance suggested the presence of a hemangioma. This case was studied at necropsy, but the lesion was not recognized as an angioma by Gold. Bailey and Bucy reported a case, and reviewed the literature to 1929. Their patient, a woman sixty-two years of age, was subjected to laminectomy and roentgenotherapy, and recovery ensued. They stated that to their knowledge the patient was the second to be operated upon successfully, and this statement seems to be borne out by a review of the literature.

Schmorl has given the best summary of the pathological features of

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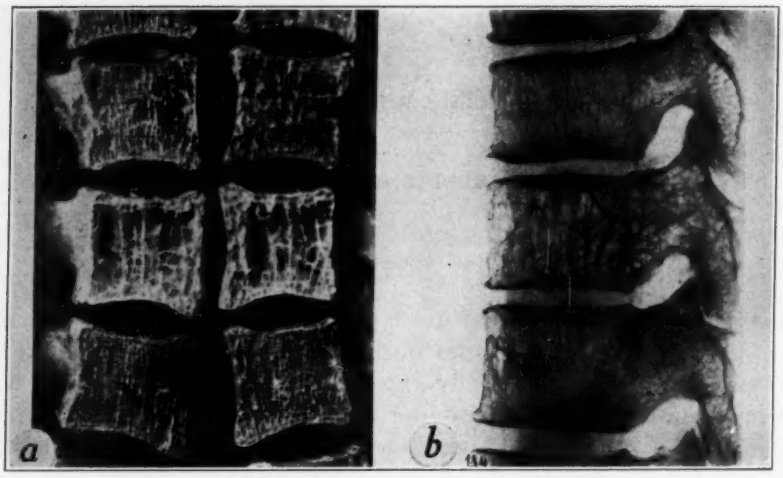

FIG. 1

a: Sagittal section through three vertebrae; the middle vertebra being the site of the hemangioma; *b:* roentgenogram of the same specimen. (*Reproduced by the courtesy of Georg Thieme*[7].)

vertebral hemangioma. In his laboratories vertebrae from 3829 spinal columns were studied, 1948 from men and 1881 from women; and the frequency with which hemangiomata occurred was recorded. Of these 3829 cases, angiomata were present in 409, or 10.7 per cent. In this group of cases, angiomata were found in 8.9 per cent. of the men, and in 12.5 per cent. of the women. In 272, or 66.5 per cent., of the 409 cases only one angioma could be demonstrated in the spinal column. In 134 cases, or 32.8 per cent., two to five angiomata, and in three cases, or 0.7 per cent., even more angiomata could be counted in the vertebral column. In all, according to Schmorl, 579 different angiomata were found in the 3829 spinal columns investigated, of which thirty-two were located in the cervical, 350 in the thoracic, and 170 in the lumbar vertebrae, and twenty-seven in the sacrum. The most frequent sites were the twelfth thoracic vertebra (forty-seven cases), the fourth lumbar vertebra (thirty-eight cases), the first lumbar vertebra (thirty-seven cases), the second lumbar vertebra (thirty-six cases), and the third lumbar vertebra (thirty-six cases).

The majority of Schmorl's angiomata were incidental findings at routine necropsies. They did not have any clinical significance, and were not demonstrable roentgenographically. These tumors may occur in any vertebra, may vary in size, and may be located in different portions of the vertebrae. Schmorl further pointed out that in the pathological specimen the angiomata are recognized by their dark red color. Microscopic studies disclosed that angiomatous tissue grows independently, and thereby destroys the trabeculae of bone. The remaining trabeculae at times become markedly thickened, so that the roentgenographic appearance is that of a field of decreased density, with a few thickened trabeculae of bone, which usually run vertically and parallel at small intervals.

TABLE I

HEMANGIOMATA OF VERTEBRAE ACCORDING TO AGE, SEX, AND LOCATION

Group	Average Age (*Years*)	Patients		Vertebrae Affected																	
				Cervical		Thoracic												Lumbar				
		Male	Female	6	7	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
1	45.6	2	3					2	1					1								1
2	45.0	1	4											1				1		3		
3	45.1	3	6	1				1					1					3	2	1		
4	59.4	6	14			1*			1				1*		2		2	2	6	5	1	
Total	53.0	12	27	1	0	1	0	3	2	0	0	0	2	2	2	0	2	6	8	9	1	1

* One patient had two hemangiomata.

This same type of structure of the spongiosa of vertebrae was seen only once in any other condition, and in that case (a case of metastasizing lymphogranuloma) it was less pronounced. Schmorl, therefore, regarded these columns of bone trabeculae as peculiar and significant to the differential diagnosis of vertebral angiomata. Bailey and Bucy described the roentgenographic appearance of a hemangioma as a "reduction of bone density between parallel trabeculae which are increased in density". This description has been used by others [1].

The question of why some patients have symptoms and others do not has brought out some interesting speculations. According to Schmorl, in cases in which the whole vertebral body is involved by angiomata, some "ballooning" is seen, so that in the lateral roentgenogram the normally indented anterior margins of the vertebral body appear straight or even seem to bulge forward (Fig. 1 *a* and *b*). He assumed, further, that two types of angiomata must be distinguished: (1) the vascular widening of the vertebral bodies which gives an angiomalike formation, and (2) definite neoplasms which have a pronounced tendency to proliferation. However, he stated that present knowledge is too limited to express a final opinion.

Schlezinger and Ungar gave as possible causes of compression of the spinal cord: (1) epidural angioma, present in eight of forty cases reviewed by them; (2) a "blowing" up of the vertebra, caused by thrombosis and oedema associated with osteoporosis and subsequent formation of new bone; and (3) compression fracture of the involved vertebra, which, according to them, is rare,—they found only four cases recorded in the literature. These reasons seem to be adequate explanations for the causes of paraplegia, and perhaps for most of the local symptoms. It is known that some patients may have an extension into the spinal canal and epidural spaces, and that hemangiomata in any situation may at times cause extreme pain, a phenomenon explained on the basis of thrombosis associated with inflammation and swelling. In at least two cases of this

series, a compression fracture was superimposed on the hemangioma. Symptoms seemed to date from the compression fracture.

The higher incidence of symptoms among young patients probably indicates an earlier and more extensive hemangiomatous change. It also should be noted that in the authors' patients with compression of the spinal cord by hemangioma, and on whom operation was performed, all but one of the hemangiomata were located in the thoracic vertebrae. This is to be expected, as the cord is larger and the canal smaller in this region.

Schmorl noted that, from the age incidence in his cases, it could be seen that the frequency of angiomata among both men and women increased with advancing age. According to Schmorl, only 3 to 4 per cent. of young persons have vertebral angiomata. This percentage increased to 12 for men more than sixty years of age, and to 16 for women of this age. Accordingly, he felt that angiomata seemed to form with advancing age or, if they were actually present at birth, that they progressed in size.

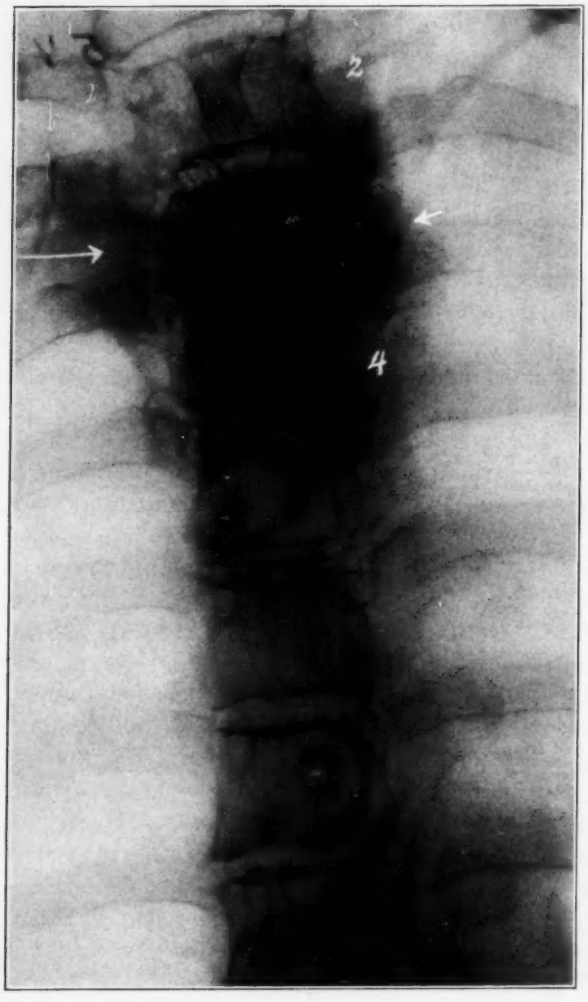

FIG. 2

Hemangioma of the third thoracic vertebra of a woman, aged forty-nine. Symptoms of one year's duration and paraplegia were relieved by laminectomy and roentgenotherapy. The patient is well eight years after operation.

However, the more the literature is reviewed, the more one is impressed with the discrepancies in the statements of various authors. This is probably because the cases fall into four distinct categories: (1) hemangioma with paraplegia; (2) hemangioma with symptoms of

compression of the spinal cord, but without paraplegia; (3) hemangioma with local symptoms and signs, but without evidence of compression of the spinal cord; and (4) hemangioma without any symptoms or signs. The diagnosis in the fourth group is made from the roentgenogram, and the lesion is usually an incidental finding.

FIG. 3

Roentgenogram shows oblique view of lumbar vertebrae of man, aged forty-four years. Hemangioma is in part of the body of the first lumbar vertebra. His symptoms were minimal.

DATA ON CASES STUDIED

The authors' series consisted of thirty-nine patients, of whom twenty-seven, or 69 per cent., were females, and twelve, or 31 per cent., were males (Table I). This is an even higher percentage of incidence among women than that reported by Schmorl (57.7 per cent.). One of the striking facts brought out in this review is the lower average age of patients who had symptoms. In the first three groups, the average age was about forty-five years, while in the group of patients who did not have symptoms the average age was about fifty-nine years.

Group 1. In the five patients in this group who had hemangioma with paraplegia, operation with or without subsequent roentgenotherapy was the method of treatment. Two patients are dead. One of these died six weeks after operation without improvement; paralysis finally became complete. The other patient, who died six years after operation, had improved markedly and was able to walk. Death apparently was caused by a cerebral accident. One patient improved markedly after laminectomy and decompression, followed by roentgenotherapy. The two remaining patients apparently recovered. Laminectomy was performed on each patient; one also received roentgenotherapy (Fig. 2).

Group 2. In this group are included five patients with hemangioma

in which there were symptoms of compression of the spinal cord, but complete paraplegia was not present. Each patient received roentgenotherapy. A supportive corset or brace also was used in most cases. One patient did not improve. Two improved and two are well, four and six years after diagnosis. Permanent cure is not yet certain, as not enough time has elapsed, but there is no question that these patients improved markedly from roentgenotherapy alone.

Group 3. In this group are included nine patients with hemangioma, in whom the only complaint was that of local pain, and in whom there was no evidence of compression of the spinal cord. In these patients, the hemangioma seemed to be responsible for the symptoms. Seven patients in this group were treated with roentgen rays. For two patients a corset only was used,—in one of these because a medicolegal question was involved. Improvement was not noted in these two cases. Three patients, treated with roentgen rays, have improved, one has been observed for too short a time for the result of treatment to be certain, and the result of treatment of another is not known. Two did not follow the treatment prescribed, and have not improved.

Group 4. The last group included twenty patients in whom symptoms, if present, did not seem to be attributable to the hemangioma (Fig. 3). No follow-up study has been made of this group. Several patients have been examined repeatedly at the Clinic without any evidence of change of status of the lesion being found, but it must be realized that symptoms may develop later.

SYMPTOMS

Localized pain with associated muscle spasm and rigidity of the spinal column are usually the first symptoms to appear in these patients. Other symptoms, such as hyperaesthesia, hypo-aesthesia, radiculitis, and complete transverse myelitis, develop as the severity of the lesion increases. As previously stated, a localized hemangioma may appear as an isolated involvement of the body, pedicle, lamina, or spine, without involving the entire vertebra, and, when such a condition does exist, the nerve roots and the spinal cord may escape injury. However, the lesions which confront the neurosurgeon are those which have resulted from an extensive involvement of the entire vertebra. Nerve roots are frequently impinged by the hypertrophy of the pedicles. Localized, radiating pain is produced, corresponding to the root involved. The crushing, flattening, and ballooning process of the vertebra often results in a sudden motor paralysis of the extremities below the lesion. The paralysis may disappear temporarily on rest in bed and extension, but sooner or later it reappears as the spinal canal is narrowed, and the cord is compressed to such a degree that all function is lost below the level of the lesion.

DIFFERENTIAL DIAGNOSIS

The symptoms produced by cavernous hemangioma of the vertebra are not unlike those produced by an intraspinal tumor, with the exception

that the symptoms develop much more rapidly than those of a benign neoplasm of the cord. The symptoms of a hemangioma of the vertebra probably resemble more the symptoms produced by a metastatic lesion of the spinal column, perhaps with the exception that the metastatic lesions progress more rapidly than those resulting from the cavernous hemangioma. Thus it is extremely important to conduct a thorough general examination, along with the neurological examination, to rule out the possibility of a primary malignant lesion elsewhere. In the early stages of the disease, before complete block in the spinal canal has occurred, studies on the spinal fluid may reveal no abnormality. Lipiodol may flow freely past the diseased vertebrae. As compression occurs, the spinal canal is narrowed and block results in the subarachnoid spaces. This condition is readily recognized by a positive Queckenstedt test,—that is, a failure of the cerebrospinal fluid to rise in the manometer after jugular compression. The spinal fluid may be xanthochromic, and its content of protein is sure to be increased, although the cell count will probably be normal.

Roentgenographic studies of the involved portion of the spinal column usually reveal pathognomonic evidence of the disease. Studies in the earlier phase of the disease will reveal areas of hypertrophy of the pedicle and lamina, enlargement of the intertrabecular spaces, and absorption of trabeculae in the body, with thickening of other trabeculae, thus giving the appearance of channels situated between or interwoven among the trabeculae. In the more advanced stages of the disease, according to Schlezinger and Ungar, a ballooning process takes place, the body of the vertebra is flattened, and the walls have a tendency to bulge. This process accounts for the narrowing of the spinal canal. In a few instances a pathological fracture has occurred, which accounts for the kyphosis or scoliosis.

In reviewing a series of records of patients who had been operated on for a variety of vascular lesions within the spinal canal, it was interesting to note that none of these had an accompanying cavernous hemangioma of the vertebra. The vascular lesions involved were extradural angiomata, subdural hemangiomata, and hemangio-endotheliomata, varices, and arteriovenous fistulas. The laminae were often more vascular than the normal laminae, but in no instance did the roentgenogram reveal evidence of a cavernous hemangioma.

Since the roentgenographic findings reveal pathognomonic evidence of the disease, it is essential that careful roentgenographic study be made in all cases in which the symptoms are suggestive of a cavernous hemangioma of the vertebra. An early diagnosis is essential in order to prevent the pathological fracture of the vertebra and, moreover, the institution of roentgenotherapy will help to prevent the flattening and ballooning process of the body of the vertebra, and the use of a spinal support with corset or brace will eliminate the disastrous result of compression of the spinal cord.

LAMINECTOMY

It was necessary to resort to laminectomy in five patients (Group 1) in whom compression of the cord was present. The procedure is designed to decompress the spinal cord. In no instance was the dura opened. In all cases, excessive bleeding was encountered during laminectomy. In performing the operation, the laminae were found to be hypertrophied and cancellous, and contained numerous and large vascular channels. Bleeding was often so profuse that bone wax would not adhere sufficiently to the rongeured edges of the laminae to control the hemorrhage. It was then necessary to resort to electrocoagulation of the rongeured surfaces of the laminae before applying bone wax. It was also found advantageous to use a bone wax of firmer consistency than that usually employed in craniotomy. In order to facilitate the application of the wax, it was warmed to a soft putty-like consistency before application. Then, as it returned to the temperature of the body, it became firm enough to remain adherent to the channel walls of the raw surfaces of the laminae.

The cord was always found to be compressed from the posterior bulging of the body of the vertebra and the hypertrophy of the pedicles and laminae. The extradural fat was more vascular than normal, but none of it contained true angioma. In one of the five patients a postoperative hemorrhage occurred, so that it became necessary to return the patient to the operating room for evacuation of a soft clot and further hemostasis. Another of the five patients obtained a most satisfactory result for six years, was able to walk about and carry on his regular activities. Then symptoms of compression of the spinal cord again developed. Results of a second operation were unsatisfactory, because complete transverse myelitis had occurred. The recurrence in this instance was undoubtedly due to a progression of the disease in the body of the vertebra, and the failure on the part of the patient to wear an adequate brace. Rhizotomy was performed at the time of the second operation in order to relieve the root pain, since it was impossible to decompress the nerve roots involved without further weakening the spinal support. It is, therefore, apparent that even though laminectomy is resorted to, extreme care should be taken to assure the patient of spinal support. In most instances, a well-fitting Taylor brace or corset with steel back support is sufficient. Although bone grafts have not been used, it is possible that a bone graft applied at the time of laminectomy is a justifiable procedure to assure the patient of the additional support needed to avoid more compression of the vertebrae and a pathological fracture. Roentgenotherapy appears to be indicated in cases in which laminectomy is performed, as well as in those in which it is not performed.

ROENTGENOTHERAPY

Roentgen treatment consisted in application of roentgen rays to the affected vertebra through four posterior fields. Each field received a dose of about 500 roentgen units. The technique was as follows: 135

kilovolts, at a distance of sixteen inches (forty and six-tenths centimeters), five milliamperes, and six millimeters of aluminum filtration. This dose was repeated at intervals of four to six weeks for three to four treatments, and thereafter once or twice a year over a period of four years. The number of treatments depended on the findings on clinical and roentgenographic examination.

SUMMARY

Evidence points toward vertebral hemangioma as a definitely recognizable condition which often does not cause symptoms. However, the symptoms of some patients, particularly the younger ones, may be marked, even to development of complete paraplegia. In such cases laminectomy with decompression, followed by roentgenotherapy, offers the best possibility of relief. In patients in whom paraplegia is not present but in whom there is evidence of compression of the spinal cord or local symptoms, roentgenotherapy is the treatment of choice. Supportive corsets or braces should be used whenever they are indicated,—for instance, with patients who have the static type of pain or sufficient involvement of the vertebra by the hemangioma to cause a pathological compression fracture. This latter complication, however, is rarely noted.

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FRACTURES OF THE TIBIA IN ADULTS

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The purpose of this report is to compare the operative and non-operative treatment of fractures of the tibia in adults, and to analyze the results of treatment of eighty-two tibial fractures out of 354 which occurred among 35,000 cases of trauma of all types during the ten years from 1929 to 1938. Tibial fractures are chosen because of their relatively high incidence. Moreover, they represent serious injuries, take a long time to heal, and involve economic handicap. The work was done by the staff and certain individuals, who for training or other reasons, were attached to the staff temporarily under the direction of William Darrach, M.D., Clay Ray Murray, M.D., and Barbara Stimson, M.D.

In the early period of the organization of the Fracture Service, the open reduction of fractures of the long bones was successful only in so far as an average good general hospital could make it. At that time vanadium steel plates were still being used, and a certain number of surgical tragedies took place when these plates or their screws broke under the vibratory stress of the constant fibrillary movement of muscle tone.

In order to establish a scientific basis for the operative method, experimental work was begun on a stainless steel material, using it on dogs as it would be used physiologically in the operating room. After two years of experimentation, and of the study of its behavior in the tissue and its metallurgy, it seemed that the material was more suitable for fixation of fractures in open reduction than the vanadium steel [1]. Before 1936 only those patients with fractures of the shaft of the tibia were operated upon who could not be adequately treated with other methods. After that date, in consequence of these experiments, all fractures of the shaft of the tibia, except those involving the cancellous portions of the condyles and the cancellous portion about the ankle, were considered primarily as operative cases, and were treated as emergencies.

The material analyzed in Table I is subdivided into three groups:

From 1929 to 1931 inclusive, the Fracture Service was in its formative period, and the conservative, non-operative methods then in prevalent use were utilized in the majority of cases. It should be remembered that even in this period the senior members of the staff already had a collective experience of handling fractures, beginning in 1901, which if not optimum was certainly adequate. In this early period there were twenty-six cases suitable for analysis. Nine were treated operatively and seventeen by closed methods.

During the period 1932 to 1935 inclusive, there was a wider applica-

tion of the operative method. Furthermore, the overlap from the general surgical divisions was considerably reduced as far as temporary personnel was concerned. In the group treated during this period there were twenty-seven patients. Of these, thirteen were treated by open reduction and fourteen by closed methods.

During the period 1936 to 1938 inclusive, the Fracture Service had evolved to its present form, and operative fixation of fractures had been adopted as the method of choice. Twenty-nine cases are considered in this group, twenty-three of which were treated by operative fixation and six by closed reduction.

Thus in the three groups, the proportion of patients operated upon to those not operated upon was nine to seventeen for 1929 to 1931 inclusive, thirteen to fourteen for 1932 to 1935 inclusive, and twenty-three to six for 1936 to 1938 inclusive.

BASIS OF STUDY

Standards for Follow-up. It is worth emphasizing that of all the cases seen in this Clinic, 90 per cent. are followed in some way. However, in this analysis only those cases which have gone to complete restitution, or have reached a stationary level for at least a year, are to be considered. Moreover, only cases are considered for analysis in this series for which the charts contain adequate and full notes on the periodic evaluation of the patient with regard to anatomical, physiological, and economic status. Records of cases included also contain enough of the history of the injury, the course of rehabilitation, and the personality as a whole to allow some conclusion to be drawn as to whether or not compensation or liability, if present, affected the period of rehabilitation. This has resulted in the selection of only eighty-two cases out of a total of 354 patients of all ages with fractures of the tibial shaft.

A better conception of the types of cases included in this analysis, aside from the adequacy of the follow-up, may be gained by mentioning some of the reasons for the exclusion of cases.

Reasons for Exclusion of Cases from Analysis. Of the 272 patients not included in the analysis, 180 were under eighteen years of age. These are not included because it is well known that fracture healing in the young has an entirely different course from that in the adult. Others are excluded because the records are inadequate for the data required, the follow-up was incomplete, or the fractures involved the upper or lower cancellous portions of the tibia, or were pathological. Those patients with multiple fractures, which make adequate evaluation of the fracture of the tibial shaft impossible, those who died from causes not connected with the method, and those who were first seen weeks or months after the injury, are also excluded.

Criteria for Evaluation of Healing. The determination of bony union is based on (1) roentgenograms, (2) clinical evidence, and (3) the ability of the patient to bear full weight without any external support. While

these are the criteria of bony union, many patients were able to return to work long before it was established. Some of these, in whom the fracture was simple and uncomminuted, and in whom rigid internal fixation was possible, returned to sedentary work in from one to two months, either in walking boots or weight-bearing calipers which usually extended only to below the knee, though occasionally included a thigh cone.

Definition of Method. Under the term "closed method" are included all procedures such as manipulative reduction with application of plaster, skeletal traction with suspension, double-wire fixation either in traction or with the application of plaster, and any other type of treatment short of operation. Under the term "operative treatment" are included cases of both simple and compound fractures, treated by open reduction with or without internal fixation.

Concomitant with the development of the Service by improvement in technique and observation of cases, operative fixation of fractures has come to be considered adequate only when rigid enough to allow mobilization of the contiguous joints as soon as, or even before, the operative wound is healed. Operative fixation was adopted as a method of choice in the fall of 1935.

ANALYSIS OF CASES

From the point of view of time required for union by the criteria previously mentioned, the following arbitrary standards are laid down:

1. Those cases in which bony union was established in six months are considered as being within physiological limits of healing.
2. Union by seven months to a year is considered as delayed.
3. Delay beyond a year is considered as non-union, even though ultimate healing occurred after that time.

The healing time for the patients who were operated upon for either compound or simple fractures was distinctly shorter than for those who were treated conservatively. This of course was not always true if a delay of several days or more took place between the injury and operation.

There were many factors which determined whether or not union occurred in a particular case. There were circumstances which make understandable the group of delayed unions in the early period, as well as the group of non-unions. Moreover, there were conditions and influences which were so complex and imponderable that proper evaluation of them would exclude enough cases to render this series unsuitable for analysis,—the time factor, the psychological status of the patient, that is, whether or not the patient was eager to get up and about and back to his work. For example, there were compensation cases which grew into cases of malingering, and some patients even caused self-inflicted wounds to delay soft-part healing. Other important considerations were: the period between injury and hospitalization, the type of emergency treatment given, the nature of the fracture itself, the importance of the accompanying soft-part involvement, and the infinite nuance in circumstances

TABLE I — TREATMENT AND RESULTS

Year	Union (*Months*)			Delayed Union (*Months*)						Non-Union (*Years*)					
	4	5	6	7	8	9	10	11	12	2	3	4	5	6	9
1929	cl. cl. cl. op. fx.	cl. cl.		cl.			cl.			cpd. ofx. cpd. ofx.	cl.				
1930	cl.	cl. cl. cl. cl.	cl.	cpd. ofx.								cpd. ofx.		op. fx.	
1931	cl. cl. op. fx. op. fx.	cl.	cl.												
1932	cpd. ofx. cpd. fx.	op. fx.											cpd. ofx.		
1933		cl. cl. cl. cpd. ofx.	cl. cl.							cpd. fx.					cl.
1934	cl. cl. op. fx.	op. fx. cpd. ofx.	cl. cl.		cl.										
1935	op. fx. op. fx.	op. fx.	cl. cl.		cl.								*cpd. fx.		
1936	cl. cl. cl. op. fx. op. fx.	cpd. ofx. cpd. fx.	op. fx. cpd. fx.		cpd. fx.										
1937	op. fx. op. fx. op. fx. op. fx. cl.	cl. op. fx.	op. fx.	cpd. fx.											
1938	op. fx. op. fx. op. fx. op. fx. cl.	op. fx. op. fx.	op. fx. cpd. fx. cpd. fx.												

cl. = Closed reduction of simple fracture.
op. fx. = Operative fixation of simple fracture.
cpd. fx. = Compound fracture with internal fixation.
cpd. ofx. = Compound fracture, with no internal fixation.
* With loss of substance in five years.

TABLE II

DISTRIBUTION OF CASES TREATED BY OPERATIVE AND NON-OPERATIVE METHODS

Year	Suitable for Analysis		Unsuitable for Analysis			Total
	Open	Closed	Open	Closed	Deaths	
1929	3	8	1	22	0	34
1930	3	6	1	18	1	29
1931	3	3	0	31	1	38
1932	4	0	0	25	0	29
1933	2	6	1	25	0	34
1934	3	5	0	15	0	23
1935	4	3	0	30	2	39
1936	7	3	0	39	6	55
1937	7	2	0	28	1	38
1938	9	1	0	25	0	35
Totals	45	37	3	258*	11	354

* This figure includes 180 patients under eighteen years of age.

which had direct or indirect bearing on the course of the disease or the recovery.

The cases shown in Table I are well scattered, from healing at four months to non-union. This includes patients treated operatively and non-operatively. It is worthy of note that although there are nine cases of non-union out of the fifty-three up to 1936, there have been none in twenty-nine cases since 1936. There is a distinct trend away not only from delayed unions, but from non-unions as well. For example, from 1929 to 1935 inclusive, four closed reductions resulted in delayed union. Another delayed union was in a patient whose compound fracture was treated without internal fixation. However, of the cases treated since 1936, only two have resulted in delayed unions. In one of these there was ample reason for slow healing. It was a badly injured limb with marked soft-part involvement and loss of bony substance. In fact, in attempting to restore length to the limb, corner-to-corner contact was all that could be obtained. A plate was used to bridge the gap and hold length, but cross fixation was impossible. The fixation held only temporarily, because infection followed the marked soft-tissue involvement, and the screws holding the plate pulled out. At three weeks a Kirschner wire was put through the os calcis and incorporated in the plaster, in order to maintain the position and length originally obtained. Actually, this case cannot be counted against internal fixation of compound fractures, because, aside from the loss of bony substance and the presence of infection, the internal fixation was only partially and, even then, temporarily, effective.

For comparison, there are twenty-seven cases from 1936 to 1938 inclusive. Fifteen healed in four months. Five patients were treated

by closed methods, and ten were operated upon and had internal fixation.

The six patients in whom healing took place in five months, with the exception of one who had a closed reduction and one who had a compound fracture, were all operated upon, and internal fixation was used. The patient with the compound fracture, although operated upon, did not have internal fixation, because of lack of displacement and a small compounding wound.

The six patients who were healed in six months were all operated upon, and had internal fixation. These included three with compound injuries.

Observe that up to 1936, sixteen patients out of thirty-nine were healed in four months. These were *almost equally divided between patients who were operated upon and those who were not.* In the later group, from 1936 to 1938 inclusive, fifteen patients out of twenty-seven were healed in four months, *ten were operated upon and five were not.* Again, in the early group of patients, thirty-nine were healed in six months. However, *in this same period there were also fourteen cases of delayed or non-union.* In contrast, the later group of twenty-seven patients were healed in six months, but in the same period there were only two cases of delayed union.

It may seem that the series of cases analyzed is too small to warrant a definite conclusion. However, it must be emphasized that in the selection of material, a rigorous standard for follow-up was applied.

The cases used in this series contrast the end results in operative and non-operative treatment of fractures. The non-operative methods have already been mentioned, and include those in prevalent use. The operative treatment is adequate for comparison only when rigid internal fixation is attained. The methods used to accomplish this have been considered elsewhere [2]. This improved operative method together with the fact that the operative method was used more generally from 1936 on, instead of being limited to emergency cases, doubtless influences the comparison.

On this Service, at present, fractures of the tibial shaft in adults are considered emergencies, and the patients are operated upon as soon after the injury as surgical and medical evaluation is made,—that is, within an hour or two. In a simple case, which is treated early and where rigid internal fixation is attained, the period of hospitalization may be two weeks. Weight-bearing is expected in between one and two months, though the extremity is protected by a walking boot or weight-bearing caliper below the knee, and very occasionally a thigh cone. Solid bony union is usually attained within four months.

In compounded cases, hospitalization is usually longer, and is determined in part by whether or not infection supervenes. When it does not, the wound is allowed to close or may be treated by pinch grafts at intervals of two or three weeks. In these as well, bony union is expected in four months or soon thereafter.

Where the compounding is complicated by infection, the axis and length of the bone are retained, and bony union follows at a slightly slower rate, usually within six months. The infection seldom spreads.

To date, there has been no loss of limb or life attributable to the open method, despite the fact that as yet none of the newer drugs, such as sulfanilamide, has been used as a prophylactic against infection.

SUMMARY AND CONCLUSIONS

The results of the operative and non-operative treatment of fractures of the tibial shaft in adults over a period of ten years have been compared. The concrete basis for the evolution of a surgical perspective under the conditions existing and under a continuity of organizational guidance has been studied.

Based upon the analysis of the cases considered, the operative treatment of compound or simple fractures of the tibia in adults, gives a surer course and better results than do the non-operative methods.

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OSTEOCHONDRITIS DISSECANS OF ANKLE JOINT

The Use of Tomography as a Diagnostic Aid

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The term "osteochondritis dissecans" was coined in 1905 by König; however, Alexander Munro as early as 1738 recognized the condition. This diagnosis is used to denote a disease of obscure origin, characterized by the demarcation and detachment of one or more fragments from the articular cartilage and underlying bone of some joint surface. Pathologically, osteochondritis dissecans is an aseptic necrosis of bone, the inception of which is frequently associated with trauma. For discussions of the various theories of etiology of this condition the reader is referred to the bibliography accompanying this article.

According to Conway more than 85 per cent. of the reported cases describe this disease as it affects the knee joint; the elbow seems to be next in point of frequency. Relatively few cases of involvement of the hip, metatarsophalangeal, or ankle joint have been reported. In the literature at their disposal, the authors have been able to review but seventeen cases of osteochondritis dissecans of the ankle joint, and to their knowledge there are reports of but two other established cases, the published accounts of which, unfortunately, have not been accessible to them.

Most of these cases occurred in young adults, and in virtually all there was a definite history of trauma. The most constant symptom was pain in the ankle, usually coming on after prolonged standing or walking. In light of the paucity of the literature on the subject, it is felt that osteochondritis dissecans of the talus is certainly not of common occurrence, and that it is justifiable to add another case to the reported series, supplying a bibliography to the other authenticated cases on record. The case reported below is of especial interest in that the diagnosis depended upon the use of tomography, as conventional roentgenograms of the joint were negative.

CASE REPORT

F. H., a lumber clerk, aged thirty-four years, was seen by one of the authors (M. C. M.) eight months after he had sustained an injury to the right ankle joint, resulting from an eight-foot fall from a platform. The patient had landed on both his feet, breaking the fall with his hands. Immediate total disability resulted in the right ankle, and roentgenograms revealed a chip fracture of the anterior aspect of the distal end of the right tibia, involving the internal malleolus. Plaster immobilization was applied and retained for eight or nine weeks, and was followed by physiotherapy. The patient returned to light work.

The past history was essentially negative, with no specific bone injury or previous joint disability relative to the right ankle.

FIG. 1-B

Conventional roentgenogram, lateral projection, taken November 28, 1940, shows no evidence of osteochondritis dissecans tali.

FIG. 1-A

Conventional roentgenogram, anteroposterior projection, taken November 28, 1940, shows normal appearing talus and tarsal bones.

FIG. 2-B

Tomogram, lateral projection, taken December 4, 1940, localizes the loose fragment of bone displaced from the posteromesial aspect of the talus.

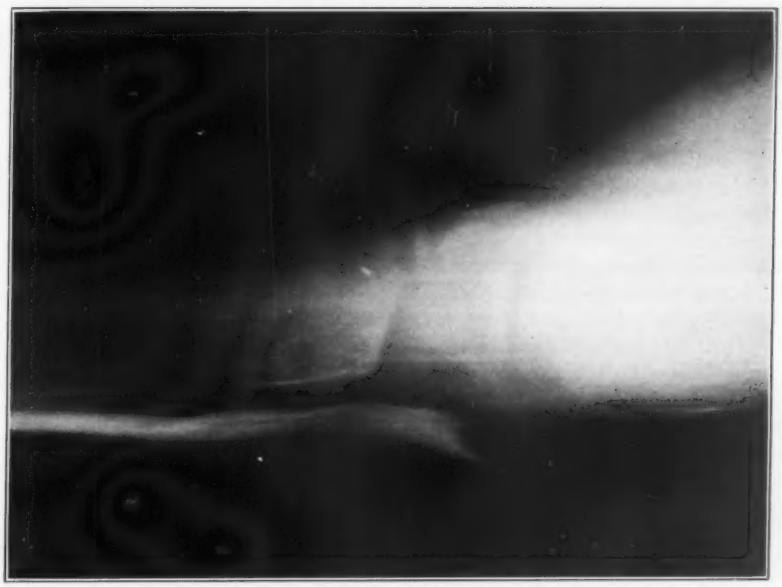

FIG. 2-A

Tomogram, anteroposterior projection, taken December 4, 1940, shows osteochondritic process on the superior articular surface of the talus.

When seen, the patient complained of an occasional recurrent pain in the right ankle, localized mesial to the internal malleolus, unrelated to activity, and not relieved by rest. There was no tenderness anywhere about the ankle. The patient also stated that there was recurrent giving way of the right ankle inwardly, sufficient at times to cause the patient to fall. There had been numerous episodes of "slipping" of the right ankle, unaccompanied by loss of balance.

Examination

The patient carried a cane, and on discarding it walked with an intermittent limp, but on a good base. He placed his foot flat on the floor with loss of the natural spring. He rose and walked well on his toes. In the squatting position, he complained of discomfort over the anterior aspect of the ankle joint, and difficulty in dorsiflexion of the right ankle. Weight-bearing statics revealed bilateral flattening of the anterior arches, and the right foot showed a mild cavus and claw-toe deformity. There was some mild apparent thickening in the space in front of the Achilles tendon, and prominence of the external malleolus on the right.

Circumferential measurements six inches below the patella were twelve and three-quarters inches on the right and fourteen and one-quarter on the left; the bimalleolar measurements were ten and one-quarter inches on the right and ten and one-eighth inches on the left; and the mid-tarsal measurements were ten and one-quarter inches on the right and ten inches on the left.

FIG. 3

Photograph of the osteochondritic body removed from the superior articular surface of the talus.

Foot Motions: Dorsiflexion was limited to 4 degrees, and plantar flexion to 14 degrees. Inversion was slightly limited when compared with the left foot; and eversion was limited 35 per cent. Forced passive inversion referred pain mesial to the internal malleolus. There was no peroneal pain complained of at this time.

Reflexes: Knee and ankle jerks were equal and active. Inspection of patient's shoes disclosed equal wear on analogous locations on both shoes.

Roentgenograms: Conventional roentgenograms of the right ankle, taken March 26, 1940, showed an irregular compression deformity of the tibial cortex just proximal to the ankle joint, with a comminuted fracture of the tip of the internal malleolus. There was no evidence of bone injury in any of the tarsal bones. Subsequent roentgenographic study of the talus and ankle joint on November 28, 1940 (Figs. 1-A and 1-B), showed good healing of the fractures previously reported, and no evidence of demonstrable injury to the talus or other tarsal bones. On December 4, 1940, tomograms were made of the right ankle in the anteroposterior and lateral projections (Figs. 2-A and 2-B), and with the plane passing through the ankle parallel with the plane of the ankle joint. These examinations showed the presence of a loose fragment of bone displaced from the posteromesial aspect of the talus, and measuring approximately one by two centimeters in length by five-tenths of a centimeter in thickness. The fracture of the anterior end of the tibia near the joint surface was healed.

Diagnosis

A definite diagnosis of a loose body in the right ankle joint was made, for which arthrotomy was recommended and subsequently carried out.

Operation

On December 27, 1940, at Stanford University Hospital, an arthrotomy of the right ankle joint was performed through a posterior approach. On the posterosuperior margin of the talus, as demonstrated by the tomogram, a definite "joint mouse", about one by two centimeters, and irregular in character, was found loosely adherent by fibrous tissue to the articular surface of the talus. This was dissected free and removed (Fig. 3). Further inspection of the dome of the talus revealed several irregularities in the articular cartilage, and a definite defect in the bone where the "joint mouse" was removed; this was replaced by fibrous tissue to some extent. The capsule and other layers were closed with interrupted silk sutures, and a dry compression dressing was applied.

Postoperative Course

No immobilization was applied postoperatively and the surgical wound healed *per primam*. He was discharged on January 14, 1941, ambulatory, and was not using a cane. Subsequent to this date the patient reported to the office for rehabilitation therapy, consisting of heat, massage, and graded exercises, including bicycling.

By March 14, 1941, sufficient recovery had ensued to allow the patient to return to his original occupation. There had been no further episodes of joint instability, and his subjective complaints were confined to generalized soreness in the ankle region. For two weeks prior to discharge the patient had been able to engage in tennis matches without disability other than fatigue. Objective examination revealed the persistence of loss of 4 degrees in dorsiflexion and of 7 degrees in plantar flexion. Inversion and eversion were free and unrestricted. There was no tenderness present in the area about the ankle joint.

DISCUSSION

The case reported is mainly of interest because of two factors: First, it is another established instance of osteochondritis dissecans of the ankle joint; second, it illustrates the value of tomography in the roentgenographic diagnosis of lesions of the osseous system, and emphasizes its importance in the accurate localization of bone defects requiring operative intervention. By this means it is possible to plan preoperatively the most direct approach whereby the lesion can be reached with a minimum of trauma to the surrounding structures.

Tomography (from Greek: *temnein*, to cut; plus Greek: *graphein*, to write) is one of the several methods of body-section roentgenography, which embraces tomography, planigraphy, stratigraphy, laminagraphy, and vertigraphy. For detailed accounts of these special roentgenographic methods the reader is referred to the articles by Andrews, Grossmann, Moore, Kieffer, and Twining. The basic principle of body-section roentgenography is that by the synchronized movement of the x-ray tube and film, during exposure, about the pivot point or body section to be visualized, roentgen shadows, which otherwise would interfere with obtaining a clear and truthful reproduction of the desired plane, are eliminated, whereas the desired plane or pivot is constantly being focused on the same fixed point on the film, so that it alone is clearly and truthfully reproduced on the roentgenogram.

Shadows of objects farthest from the desired plane are most blurred, whereas those in close proximity to the selected plane are least blurred. The tomograph, introduced by Grossmann in 1935, is an extremely satis-

factory device for accomplishing body-section roentgenography. Twining, in 1937, proposed a method of carrying out tomography by means of a simple attachment to the Potter-Bucky table.

Tomography is certainly not recommended as a substitute for conventional roentgenography, but rather as an addition to the armamentarium in roentgenographic diagnosis. To be sure, ordinary roentgenograms should be carried out as indicated in the individual patient, but in the event that conventional roentgenograms are not diagnostic, and there is clinical evidence suggestive of morbid changes in the skeletal system, every effort should be made to obtain tomographic visualization of the part under suspicion.

SUMMARY

The publishing of this case brings the total number of reported instances of osteochondritis dissecans of the ankle joint to twenty. The importance of tomography in the diagnosis and localization of obscure lesions of the osseous system is emphasized.

CONCLUSIONS

1. Although but twenty established cases of osteochondritis dissecans of the ankle have been reported, the condition will probably be more frequently detected if tomography is carried out in suspected cases, despite negative findings by conventional roentgenography.

2. In the case reported, the causal relationship between the trauma sustained and the development of osteochondritis dissecans seems inescapable. This conforms to the general opinion relative to trauma as an etiological factor in the production of this disease entity.

3. Chronic pain or discomfort in the ankle—following a sprain, dislocation, or fracture—which persists despite ordinary conservative treatment, should suggest the possibility of osteochondritis dissecans tali.

4. A history of recurrent instability of the ankle should arouse suspicion relative to the possibility of a loose fragment or "joint mouse".

5. The treatment of choice is arthrotomy, with removal of the loose fragment or fragments, but without immobilization. This should be followed by rehabilitation therapy in the form of diathermy, massage, and graded exercises, which are important adjuncts in the accomplishment of prompt postoperative recovery of normal function and complete rehabilitation.

6. Prognosis is excellent in patients receiving early diagnosis and appropriate treatment. Such treatment is also a prophylaxis against the development of chronic hypertrophic synovitis and traumatic arthritis.

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THE TREATMENT OF OBLIQUE, SPIRAL FRACTURES OF BOTH BONES OF THE LEG

An Analysis of Fifteen Cases Treated by Open and Closed Methods

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Fractures of both bones of the leg are frequently seen, particularly in Marine Hospitals whose patients as a rule have been employed in hazardous occupations. The material submitted is taken from the clinical records of the fractures treated during the fiscal year 1939, in the U. S. Marine Hospital, Detroit, Michigan. The fractures included are only those of the type described below. Fractures near a joint, badly comminuted fractures, and transverse fractures are not included, as they would not allow a fair comparison. After the elimination of these types, fifteen patients remained, seven of whom were treated by closed methods and eight by open methods.

The diagnosis "fracture of both bones of the leg" includes, of course, fractures in many locations and of diverse types. There may be fractures of the shaft, fractures about the knee, or fractures about the ankle. Each of these has some peculiar clinical characteristic which influences treatment.

The fracture with which this discussion is concerned is almost a clinical entity. It is a fracture of the shafts of both bones occurring somewhere in the middle three fifths. In the tibia it is oblique and spiral in type and this is an important factor in its treatment. It may be single or comminuted. The fibula is usually fractured at a different level and in a great proportion of the cases is comminuted. It may be oblique or transverse. The fracture of the fibula is unimportant, however, and needs no special attention. Union of the fibula occurs quite readily if the tibia is properly reduced and fixed. Indeed, it often bridges large open gaps to secure good solid union.

The criteria of good treatment in these fractures are the same as in any fracture,—namely, the accurate apposition of the bone ends in as physiological a position as possible, and complete fixation in this position until union has occurred. It is believed that even a minimal movement of the apposed fragments is conducive to delayed union, a factor which has made fracture of the surgical neck of the femur so refractory to treatment until recently.

The open method of treatment of such fractures, as opposed to the various methods of closed treatment, seems logical for the following reasons: (1) Under direct vision an oblique, spiral fracture can be more readily and more accurately reduced. (2) In these oblique fractures, because of the sharp ends of the fragments, there is very often interposed soft tissue consisting of muscle or fascia or both. (3) More rigid fixation can be obtained by internal fixation.

It appeared that, in general, the results in this type of fracture were not satisfactory. Who has not seen such a fracture with non-union many months after its occurrence, or a malunion producing decided disalignment in the weight-bearing line, which brings with it chronic foot strain or a traumatic arthritis of the ankle and foot joints? In those cases in which the clinical results were good, it appeared that too long a time elapsed between the injury and the patient's return to work. A normal bone, after fracture, placed in good apposition, should show union with beginning deposition of calcium salts in five to six weeks, and solid callus in eleven to twelve weeks.

A critical survey, therefore, was undertaken of the cases with which the author had had personal contact, to find out whether, as was believed, the open procedure was productive of better clinical results in a shorter time, and was more economical to the patient and the hospital.

The findings are tabulated in Tables I, II, and III.

Table I gives data on fractures treated by closed methods. These methods are:

1. Manual reduction of the fragments and fixation by the application of a plaster dressing.

2. The insertion of Steinmann pins above and below the fracture. With the aid of the pins the fracture is manually reduced, and, while held in this position, a cast is applied incorporating the pins, thus securing better fixation than in the first method.

3. The use of some type of frame, such as the Roger Anderson or Braun frame. In this method pins are inserted in the bone as in the second method. These are attached to the parallel bars of the frame in such a way that they may be moved in any direction, and can be locked in the desired position. After a suitable time the leg is encased in a plaster dressing.

4. The use of continuous skeletal traction and the later application of a cast. This method embraces much the same principle as the frame, but the fixation is not so rigid.

As previously stated, the tibia alone is the object of treatment.

Table II gives data on the fractures treated by the open method. This consists of reducing the fractures under direct vision and internally fixing them by wire sutures, metal plates, screws, nails, or bone grafts.

After appropriate preparation, a semilunar incision is made on the anteromedial aspect of the leg over the fracture site, with the convexity directed posteriorly. The fracture site is exposed by dissecting back the skin flaps. The fracture is reduced by traction and manipulation and held in position by means of bone clamps. At this stage the reason for so many non-unions in this type of fracture is seen. In 60 per cent. of the author's patients, who were operated upon, muscle or other soft tissue was found interposed between the fragments, the sharp end of one of the fragments having speared the soft tissue. Obviously, when this situation

TABLE I

CLOSED TREATMENT OF FRACTURES OF BOTH BONES OF THE LEG

Patient	Date of Injury	Method of Treatment	Date Ambulant without Support	Total Days from Injury to Ambulant Status	Total Days Lost from Work	Hospital Days	Total Days under Treatment	Results	Complications
J. M. (11616)	Apr. 21, 1938	Steinmann pins, Böhler splint	Oct. 8, 1938	170	210	27	224	Medial angulation with disturbance of weight-bearing line	
M. H. (11684)	Apr. 29, 1938	Manual reduction and cast	Dec. 1, 1938	216	216 Clerical work	43	216	Posterior and lateral angulation disturbing weight-bearing line	Delayed union
H. P. (12100)	Nov. 26, 1938	Steinmann pins in cast after manual reduction	Apr. 4, 1939	129	216	229*	260**	Alignment good. Union good	Large indolent ulcer from long-continued cast pressure
F. P. (8589)	Dec. 1, 1938	Steinmann pins in cast after manual reduction	Not ambulant Sept. 30, 1939	303+†	303+†	21	303+†	Non-union. Lateral deviation of lower fragment disturbing weight-bearing line	See results
A. G. (12034)	Dec. 31, 1938	Manual reduction and cast	June 8, 1939	159	203	161	161	Slight anterior bowing. No disturbance of weight-bearing line	Delayed union
T. H. (12579)	Feb. 3, 1939	Skeletal traction	May 26, 1939	112	182	79	112	Good	None
C. Mc. (12635)	Feb. 15, 1939	Skeletal traction	May 25, 1939	99	106	39	100	Good	None

* This figure includes thirteen extra days incurred because of an indolent ulcer.

** This figure includes forty-four additional days' treatment because of ulcer.

† This patient is still ambulant only with the aid of a brace and crutches, and is still not working, though fit for some work. September 30 was chosen as the date on which it was definitely decided that closed treatment was of no avail. The patient has consistently refused open reduction.

TABLE II

OPEN TREATMENT OF FRACTURES OF BOTH BONES OF THE LEG

Patient	Date of Injury	Date of Operation	Date Ambulant without Support	Total Days from Injury to Ambulant Status	Total Days Lost from Work	Hospital Days	Total Days under Treatment	Highest Post-operative Pulse	Highest Post-operative temperature (*Degrees Centigrade*)	Results	Complications
L. F. (11087)	Feb. 26, 1938	May 27, 1938	Sept. 4, 1938	100*	198*	37*	168*	110	39.0	Good	None
H. H. (8679)	Dec. 20, 1938	Feb. 6, 1939	Apr. 30, 1939	83*	116*	53*	116*	110	38.3	Good	None
S. B. (12168)	Feb. 3, 1939	Feb. 15, 1939	May 24, 1939	110	170	25	160	108	38.2	Good	None
A. P. (8801)	Feb. 10, 1939	Feb. 13, 1939	Apr. 24, 1939	73	130	65	130	94	37.5	Good	None
L. D. (12275)	Mar. 7, 1939	Mar. 8, 1939	May 28, 1939	82	146 †	21 †	146†	110	38.4	Good	None from fracture †
A. S. (8930)	Mar. 19, 1939	Mar. 24, 1939	May 26, 1939	68	117	16	101	100	37.8	Good	None
J. C. (12440)	Apr. 12, 1939	Apr. 12, 1939	June 24, 1939	73	133	31	133	110	38.6	Good	None (compound fracture)
W. Y. (12683)	June 1, 1939	June 2, 1939	Sept. 11, 1939	102	132	26	122	96	37.4	Good	None

* For the purpose of this table, time of injury is taken as time of operation. L. F. (11087) had no union after ninety days following closed reduction, and at operation muscle and fibrous tissue were found interposed between the fragments. H. H. (8679) had no union or signs of union after thirty days following closed reduction, and at operation tissue was found interposed between the fragments.

† On August 1, 1939, patient developed an extraneous infection which prevented actual return to work, and required an additional thirty-two days of treatment, eighteen of them in the hospital, but this was not related to the fracture in any way. As far as the fracture was concerned, he was fit for duty.

TABLE III

COMPARISON OF OPEN AND CLOSED METHODS OF TREATMENT

Method of Treatment	Average Time from Injury to Ambulant Status	Average Time Lost from Work	Time in Hospital	Average Time under Treatment	Poor Clinical Results (*Per Cent.*)	Complications (*Per Cent.*)
Closed.....	169.71 days (5.7 months)	205.14 days (6.8 months)	85.57 days (2.8 months)	196.57 days (6.6 months)	43	57
Open.....	86.37 days (2.9 months)	142.75 days (4.8 months)	34.25 days (1.1 months)	134.50 days (2.1 months)	0	0
Difference...	83.34 days (2.8 months)	62.39 days (2.0 months)	51.32 days (1.7 months)	62.07 days (2.1 months)		

exists, it would be almost impossible to secure reduction of the fragments by closed methods.

With the fracture firmly held by bone clamps, small drill holes are made in each fragment through which silver wires are introduced. By wrapping the silver wire sutures about the bone and twisting them, the fracture is securely immobilized. The fragments cannot flare; and because the wires run through, vertical sliding is prevented. On two occasions metal plates were used, and on another occasion a bone graft was employed, but in the usual case the wire suture suffices.

The incision is closed by layers and a non-padded cast is applied from the toes to the knee.

The cast is removed in from two to three weeks, at which time the sutures are removed and the wound inspected. Another cast is applied and allowed to remain for six weeks. At the end of this period the condition of the fracture clinically and by roentgenograms is used as a guide for future treatment.

It is believed that more training in orthopaedic surgery is required for closed reduction, than for the open method which should present no obstacles to the general surgeon. It is an extremely difficult manipulation to reduce a spiral, oblique fracture, and to hold such a fracture in position is often impossible.

One of the frequently mentioned disadvantages of an open reduction is that it converts a simple fracture into a compound fracture, with increased susceptibility to infection. In none of these cases has such an infection developed, or, indeed, any type of infection. As may be seen in Table II, the postoperative reaction, as revealed by the pulse and temperature, has been minimal. It has been less severe than that shown by the average hernioplasty. It may be pointed out here, however, that the greatest attention is paid to asepsis, including the smallest details.

Table III shows averages computed from Tables I and II. It is seen

TABLE IV

COST OF OPEN AND CLOSED METHODS OF TREATMENT

Method of Treatment	Cost to Patient by Reason of Time Lost from Work *	Cost to Hospital †	Total Cost Involved ‡
Closed.....	$388.96	$320.89	$709.85
Open.....	274.56	128.44	402.90
Difference.....	$114.40	$192.45	$306.95

* Estimated on the basis of a thirty-day month at $57.20 per month. This is the figure used by the Works Progress Administration as the basic pay for common labor.

† Estimated at $3.75 per bed *per diem*.

‡ Out-patient cost at the standard figure of $1.50 per treatment has not been included in this cost. If it were, it would increase the cost for the closed method.

that patients with fractures treated by open methods were ambulant without support in two and nine-tenths months, while those treated by closed methods needed support of some type, usually a cast, for five and seven-tenths months. The patients treated by closed methods also lost more time from work, six and eight-tenths months, as compared with four and eight-tenths months, or a difference of two months.

The reason for the increase in hospital days for patients with fractures treated by closed methods over those treated by open methods is not known. Apparently the attending physician felt that it was not safe to allow the former to begin out-patient status, wearing a cast, as soon as those who had been treated by the open method, and it is a fact that a fibrous type of union, as well as bony union, occurs much earlier in the fractures which have been given open treatment.

The average number of days spent under treatment, that is, hospital days plus out-patient days, is sixty-two days, or two months, more for patients receiving the closed treatments than for those given the open treatments.

Perhaps some explanation should be given of the total lack of poor results and complications in the case of the fractures given open treatment. While it is true that only good results were encountered in this small series, this does not necessarily mean that there never would be poor results. On the contrary, in a larger series poor results would probably occur in some cases. However, even though the number of cases is small, the difference in the two series is striking enough to justify the conclusion that the percentage of poor results would be higher in the patients not operated upon. This is confirmed by operative findings, which often show a fracture which, because of interposed soft tissue, could not be properly reduced by closed methods.

It has been suggested that it would be well to try closed methods first, and, if union was delayed beyond a reasonable time, or if it appeared

that malunion would occur, then open methods. It is believed that, in view of the calm postoperative course, the ease of the procedure, the shorter time that it is necessary for the patient to wear the cast, and the better ultimate results, the procedure of choice in a fresh fracture is immediate reduction and fixation by the open method.

There was one compound fracture in this series. It was treated in the same manner, with gratifying results. If proper cleansing of the wound, together with the necessary débridement is done, it is believed that there is no contra-indication to the immediate reduction and internal fixation of these fractures, if they are seen within twelve hours of injury.

Table IV is interesting in that it approaches the problem from a different point of view. The cost of fractures treated by the open and closed method is analyzed. The figures are only a rough approximation, but they serve to make an interesting comparison. The table shows that a saving of $306.95 per patient is made by using immediate open reduction and fixation of these fractures. This is more than enough to pay for the treatment of two more similar cases.

SUMMARY AND CONCLUSIONS

From an analysis of the results obtained by the open and closed methods of treatment in fifteen cases of spiral, oblique fracture of both bones of the leg, immediate open reduction with internal fixation appears to be the procedure of choice.

A REVIEW OF TWO HUNDRED AND ONE CASES OF SUPPURATIVE ARTHRITIS *

BY JOHN A. HEBERLING, M.D., PITTSBURGH, PENNSYLVANIA

This paper deals with the method used, the results obtained, and the details of treatment in 201 patients with acute suppurative arthritis, from the Orthopaedic Department of the Allegheny General Hospital, Pittsburgh. This group includes those cases treated since 1921, at which time this method was first used at the Hospital, and the cases are from the Services of David Silver, M.D., Paul B. Steele, M.D., Carl C. Yount, M.D., and the author.

Willems [1] in 1919 discussed the use of incision and active motion in joints affected by penetrating wounds and intra-articular fractures resulting from war injuries. He also considered the advisability of the use of this method in purulent arthritis, and described the results obtained in a few cases involving the knee and elbow joints.

Two hundred and one patients, comprising a total of 221 joints, have been treated since 1921, including all of the joints of the extremities. In each case the presence of actual suppuration either was demonstrated by aspiration and culture, or the author was reasonably certain from other clinical and laboratory findings that it was present, before incision was performed. Joints which were felt to be the seat of serous or serofibrinous infection were treated by more conservative methods, and are not included in this series.

The surgical procedure carried out involves briefly the incision of the joint, under general anaesthesia, and the suturing of the appropriate-sized, soft-rubber drain to the capsule. This drain is never allowed to intrude into the joint. Active motion is started as soon as possible after the effect of anaesthesia is over, and is repeated every three hours. The joint is put through its full range of motion in so far as it is possible, and it will be found that after a few times the limb can be moved freely and without pain. Only in infants and very young children has it been necessary to depend upon passive motion. During the first few treatments a great deal of time and patience must be used to overcome the child's fear of pain, but once he finds that the procedure is practically painless, no further difficulty is encountered. It is occasionally necessary to replace extruded drains and reopen pockets, but most of this can be done without anaesthesia.

Early weight-bearing and walking was tried in a few cases but, in the author's experience, this does not hasten recovery. Ordinary adhesive traction with only a small amount of weight is used for patients with hip or knee-joint involvement. In younger children, in whom the

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, New Orleans, Louisiana, January 14, 1941.

TABLE I

INCIDENCE OF SUPPURATIVE ARTHRITIS

	Knee	Hip	Ankle	Wrist	Elbow	Shoulder	Small Joints	Multiple	Total
Number of Patients	72	65	17	10	8	7	4	18*	201
Number of Joints...	85	74	20	10	14	13	5		221
Patients with complicating osteomyelitis.....	10	6	5		1	2			24

* Eighteen multiple cases involving thirty-nine joints, one patient having four joints involved.

hip joint has been opened, the limb should be kept in abduction to prevent subluxation.

In the shoulder joint the anterior incision through the deltoid fibers has been used; in the elbow one incision posteriorly over the radiohumeral region usually suffices; and in the wrist, the dorsal incision into the anatomical snuffbox. The approach to the hip joint used most commonly has been an anterior one between the sartorius and the tensor fasciae femoris. In a few instances the posterior incision has been used, but it is felt that the anterior one is more satisfactory, particularly since it is not necessary to use dependent drainage with active motion. The knee joint is opened by a mesial anterior incision with occasionally a second one on the lateral side of the patella; and the ankle joint, by posterolateral and anteromesial incisions. After the joint is opened, it is gently flexed and extended a few times to express the contents before the drain is sutured in place.

The wound is dressed with "fluffed" gauze, piled on very loosely, and secured above and below by bandage or adhesive in such a fashion

TABLE II

TYPE OF INFECTION IN CULTURES MADE

	Knee	Hip	Ankle	Wrist	Elbow	Shoulder	Small Joints	Total
Staphylococcus aureus.....	18	22	3	2	3	1	1	50
Hemolytic streptococcus....	19	11	3		2	2		37
Negative joint culture.....	9	1	6		3			19
Gonococcus.....	8	1		4	1			14
Staphylococcus albus.....	3	3	2	1		1		10
Streptococcus viridans....	1	5	1				1	8
Pneumococcus.....		2						2
Total.....	58	45	15	7	9	4	2	140

TABLE III

AGE OF PATIENTS AND JOINTS INVOLVED *

Age †	Knee	Hip	Ankle	Wrist	Elbow	Shoulder	Small Joints	Total
Birth to one year	3	8						11
One year to ten years	13	22	6		6	4	1	52
Ten to twenty years	24	20	7	3	2	5	1	62
Twenty to thirty years	19	8	4	4	3		1	39
Thirty to forty years	11	11	2		1			25
Forty years and over	15	5	1	3	2	4	2	32
Total	85	74	20	10	14	13	5	221

* Eighteen patients are listed more than once because of multiple-joint involvement.
† Age of youngest patient was twelve days, and age of oldest patient, seventy-three years.

as to allow complete joint motion. Drains are removed and the opening is allowed to close gradually when the discharge becomes thin and scanty, and the thickening and bogginess about the joint begin to disappear.

Thirteen deaths were directly attributable to the joint infection. Of these, eight had a staphylococcus aureus blood culture, three a hemolytic streptococcus blood culture, and two a negative blood culture. Six deaths were in patients with nephritic, diabetic, and cardiac complications. These conditions were known to have been present before the joints were affected.

In this series of cases there were twenty-four patients with complicating osteomyelitis of adjacent bones of such severity that drainage or sequestrectomy was necessary (Table IV). It was possible to continue the active joint motion with all these patients, and the results obtained were not at too great variance with those in uncomplicated cases.

As criteria of so-called successful results in our tabulation, the following range of motion was accepted.

TABLE IV

RESULTS IN TWENTY * PATIENTS WITH OSTEOMYELITIC COMPLICATIONS

Results	Knee	Hip	Ankle	Wrist	Elbow	Shoulder	Small Joints	Total
Deaths		4			1			5
Followed	5	4	3		1	2		15
Stiff		1	1					2
Not satisfactory	1	2	1					4
Satisfactory	4	1	1		1	2		9

* There were twenty-four patients in this group, but four were not followed. Sixty per cent. of the patients who lived had satisfactory results.

TABLE V

RESULTS IN ELEVEN * PATIENTS WITH GONORRHEAL INFECTION OF THE JOINTS

Results	Knee	Hip	Ankle	Wrist	Elbow	Shoulder	Small Joints	Total
Deaths				1				1
Followed	6			3	1			10
Stiff	1				1			2
Not satisfactory	1			1				2
Satisfactory	4			2				6

* There were fourteen patients in this group, but three were not followed. Sixty per cent. of the patients who lived had satisfactory results.

Hip: No subluxation, flexion to 75 degrees, complete extension, and abduction to 15 degrees.

Knee: Complete extension, and flexion to 75 degrees.

Ankle: Plantar and dorsal flexion to from 20 to 25 degrees.

Shoulder: Elevation to 90 degrees, forward flexion and adduction to from 10 to 15 degrees.

Elbow: Flexion to 90 degrees, and extension to 165 degrees.

Wrist: Dorsal flexion to from 20 to 25 degrees, and palmar flexion to from 30 to 35 degrees.

In the follow-up tabulation of patients not examined recently, the statement that the joint was "movable and not stiff" at this time, was accepted as a successful result provided the joint had also been satisfactorily movable at the time of the patient's discharge from the hospital.

TABLE VI

ANALYSIS OF RESULTS FOR 112 JOINTS IN 93 PATIENTS

Results	Knee	Hip	Ankle	Wrist	Elbow	Shoulder	Small Joints	Total
Deaths (19 patients)	4	11	2	1	1			19
Joints followed (93 patients)	34	33	12	3	4	4	3	93
Joints examined	24	25	7	3	3	3	1	66
Follow-up cards	10	8	5		1	1	2	27
Stiff	2	5	3		1			11
Not satisfactory	4	9	2	1		1		17
Satisfactory	28	19	7	2	3	3	3	65
Percentage of satisfactory results in patients who lived	82	58	58	67	75	75	100	70

In checking over this series it appears that there have been more unsuccessful results in patients with hip-joint involvement, particularly in younger children, than in any of the others. It is felt that this is because of:

1. Late institution of treatment, after the purulent material has ruptured through the capsule and the head has been floated outward and upward.

2. The difficulty of early diagnosis.

3. Failure to maintain the limb in abduction and extension following incision, for a sufficient length of time.

Other reasons for bad results are:

Poor cooperation between the patient and the attendant when active motion is first begun, following operation. The surgeon, himself, must at least supervise, and in most cases carry out, the treatment until routine motion is established. This phase of treatment must not be delegated to those unfamiliar with the technique.

Insufficient drainage. In some cases two incisions at the knee or the ankle might have been better than one.

Too early removal or extrusion of the drain, and drains which may have been placed within the joint by mistake.

Operative intervention in a few patients who may have been too ill. Aspiration, washing out of the joint, or other conservative measures should possibly have been tried.

In the last few years an attempt has been made to reconcile the more radical ideas of the treatment of these purulent joints with those used in the treatment of acute osteomyelitis.

CONCLUSIONS

1. In the author's experience the Willems method of treatment of acute suppurative arthritis gives entirely satisfactory results when instituted at, or very soon after, onset.

2. Results become progressively less satisfactory in proportion to the length of time after onset at which treatment is started. This is believed to be the result of several factors:

(a) When sufficient time has elapsed for adhesions to develop, the pockets thus formed cannot be drained properly by the active movements. Indeed, it is possible, that this may be actually harmful in promoting absorption from such pockets.

(b) In cases of long standing, erosion of cartilage with denuded bone areas hinder or prevent efficient active movements.

(c) In cases of long duration, blood-stream infection is an ever-present danger, as well as an aggravation of existing organic diseases by the infectious process.

With these older cases some more radical procedure is obviously necessary.

1. Willems, C.: Treatment of Purulent Arthritis by Wide Arthrotomy Followed by Immediate Active Immobilization. Surg. Gynec. Obstet., XXVIII, 546, 1919.

PRIMARY PYOGENIC INFECTION OF THE SACRO-ILIAC ARTICULATION. A NEW APPROACH TO THE JOINT

Report of Seven Cases

BY LEON AVILA, JR., M.D., SAN SALVADOR, EL SALVADOR, CENTRAL AMERICA

From the Department of Orthopaedic Surgery, Hospital Rosales, San Salvador

That pyogenic infection of the sacro-iliac joint is an unusual condition is indicated by the fact that L'Episcopo's report of five cases is the only article the author found in the literature under this title.*

He has recently seen seven cases of primary suppurative arthritis of the sacro-iliac articulation, and in three of them has used a new approach for the drainage of this joint when abscess formation had taken place anteriorly.

TECHNIQUE OF ANTEROLATERAL APPROACH TO THE SACRO-ILIAC JOINT

With the patient in the supine position, an incision four or five inches long is made one-half inch above, and parallel to, the crest of the ilium, starting over the anterior superior iliac spine (Fig. 1). The inferior edge of the wound is dissected down, and the attachments of the abdominal muscles to the crest are cut over the superior border of the ilium, but not on its outer aspect. This is done in order to leave the skin flap and underlying structures attached to the crest of the ilium, thus preventing the retraction of the lower edge of the incision. After cutting the aponeurotic attachments of the abdominal muscles, the periosteum is incised at the same level; then, with a periosteal elevator, the iliacus muscle is stripped subperiosteally, following the anterior aspect of the ilium in a medial and slightly downward direction. This muscle is retracted medially, and from then on the periosteal stripping is carried out by the gloved finger. Going deep enough, the lateral attachments of the anterior ligaments of the joint are found; these are cut, or detached with the periosteal elevator. The joint can then be explored in all its length. By extending the incision further back, with good retraction, the articular surfaces of the ilium and sacrum can easily be exposed. The wound is left open and packed with vaseline gauze. Healing is assisted by intra-abdominal pressure, and, as it takes place and drainage diminishes, the vaseline gauze packing is gradually pushed out.

DISCUSSION

In the seven cases reported (Table I), staphylococcus infection of the joint was proved in three, streptococcus was responsible in one, and the organisms in the other three are unknown. In six cases the abscess for-

*The articles by O. C. Hudson were not known to the author until after the present article had been written.

mation took place anteriorly, and, although the iliac fossa of the affected side was painful in all, a real indication that the abscess was forming anteriorly, as a hard tumor on the iliac fossa, did not appear until the fifteenth or twentieth day after the onset of symptoms. This tumor, on exploration, proved to be the iliacus muscle which reacted to the infection in the form of an inflammatory myositis, such as is sometimes seen in the presence of osteomyelitis elsewhere. This tumor was not the abscess which was located deep in the iliac fossa, and this fact should be stressed, because it would be possible to cut into the muscle and not reach the deeper abscess.

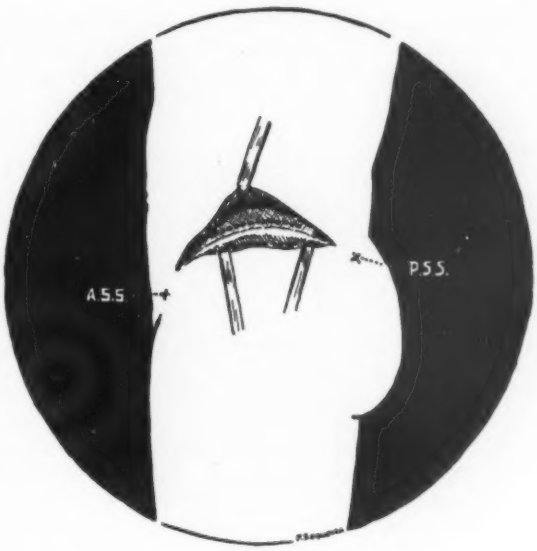

FIG. 1

Drawing of the incision above the iliac crest. Dotted line shows the location of the incision of the aponeurosis on the superior aspect of the iliac crest. The inferior edge of the wound has been retracted down for illustrative purposes.

A.S.S. = anterosuperior spine; P.S.S. = posterosuperior spine.

Only two cases will be described in detail, as the clinical picture has been practically the same in all.

CASE 1. S. E., male, aged nineteen, was well until February 27, 1940, when he felt pain in the left side of the back, which radiated down the left leg. On admission to the hospital, February 29, 1940, he was suffering such severe pain that the slightest movement was intolerable. His temperature was 39 degrees centigrade, and the blood count was: red blood cells, 3,500,000; white blood cells, 15,000. After one and eight-tenths grams of sulfanilamide had been given daily for six days, the temperature became normal, but the pain persisted unabated.

This patient was referred to the writer on March 30, 1940.

Physical Examination: There was exquisite tenderness to pressure over the left sacro-iliac region. The lumbar spine was obviously flattened, and there was marked muscle spasm in the lumbar region. There was pain along the sciatic nerve, but no objective neurological signs were elicited. The straight-leg-raising sign was positive on the left side. The abdomen was soft and painless, but on *the left side a mass* could be seen filling the iliac fossa to the anterior superior iliac spine, and all *along the fossa a hard elongated mass was felt.* Pain was only elicited on deep pressure over this area.

Roentgenograms taken March 28, 1940, showed a destructive lesion of the left sacro-iliac joint (Fig. 2-A).

Operation: Arthrotomy was performed on April 5, 1940, through the anterior approach already described.

A small amount of pus was found, and the wound was left wide open. An incision was made into the hard, fibrotic mass which was found to be the iliacus muscle. Two days after the operation, the patient began to feel relief from the pain which disappeared

completely a week afterwards. This patient was operated upon again through the same incision because of insufficient drainage; he made a complete recovery (Fig. 2-B).

On culture of the pus, the offending organism was found to be staphylococcus albus.

FIG. 2-A

Case 1. S. E. Roentgenogram taken March 28, 1940, eight days before operation, shows well the sacro-iliac joints. Note the destruction on the left; the right one is clearly seen.

FIG. 2-B

Case 1. S. E. Roentgenogram taken October 5, 1940, six months after operation, shows that the left sacro-iliac joint has started to fuse.

FIG. 3-A

Case 5. C. O. Roentgenogram taken August 9, 1940, before operation, shows some destruction of the right sacro-iliac joint.

FIG. 3-B

Case 5. C. O. Roentgenogram taken December 18, 1940, three months after operation, shows trabeculation and ankylosis on the right side.

CASE 5. C. O., a nine-year-old girl, was hospitalized on July 27, 1940, because of high temperature, inability to walk, and pain on the right side of the lower back. There was an adduction, internal rotation, and flexion deformity of the right lower limb, and *a painful tumor in the right iliac fossa* (Fig. 3-A). A diagnosis of psoitis was made, and an abscess was drained through an incision one inch above the right inguinal ligament. Due to the persistence of her symptoms, she was transferred to the Orthopaedic Service on September 8, 1940.

The tumor of the iliac fossa was still present, in spite of a draining sinus from the first operation, and there was tenderness over the sacro-iliac region on the right side, which at this time was obviously swollen and warm.

Roentgenograms taken at that time showed some increase in density of the surrounding bone of the right sacro-iliac joint.

Primary acute sacro-iliac arthritis was diagnosed, and the patient was operated upon by the anterolateral approach, disregarding the previous abdominal incision.

On culture the offending organism was found to be staphylococcus.

Operative Findings: The right sacro-iliac joint was explored in all its length. The anterior edge of the articular surface of the sacrum was sharp, and it formed a step of about one-eighth of an inch. Abnormal motion was induced by applying force on the ilium in different directions.

Postoperative Course: Two days after the operation the pain had decreased and at the end of a week had disappeared completely; the temperature became normal; the patient was allowed up at the end of a month. She had a limp, due to the deformity of the right lower limb, but no pain. By December 10, 1940, the limp had disappeared, the wound had healed, and she was able to run and jump with no trouble whatsoever. The primary wound had healed soon after good drainage had been provided by the second operation.

All cases reported in Table I were primarily of an acute suppurative arthritis. In each case roentgenograms showed only a destructive lesion of the joint. These patients were all followed for five months after discharge from the hospital, and remained well,—none complaining of pain in the back. Roentgenograms taken one and two months after the operation showed no increase in the destruction of the articulation; on the contrary, trabeculae had started to form between the sacrum and the ilium, indicating the beginning of ankylosis.

Of these patients only four required operation. Three of the operations were performed through the anterior approach, and one through the Smith-Petersen incision for the sacro-iliac joint. The three patients who were not operated upon showed all the characteristic signs of suppurative sacro-iliac arthritis, including roentgenographic, but the virulence of the pathogenic agents was probably mild, and the patients recovered under conservative treatment. Pain was the principal symptom to be considered, as temperature was controlled by the use of sulfanilamide and stock vaccines in all but two cases (Cases 3 and 5).

Two of the patients were women in whom the disease developed within three days after delivery.

SUMMARY AND CONCLUSIONS

Of seven cases of primary pyogenic infection of the sacro-iliac joint, three were due to staphylococci, one to streptococci, and the cause of three was not known. All seven patients made a complete recovery.

TABLE I

RÉSUMÉ OF SEVEN CASES OF SUPPURATIVE ARTHRITIS

Case No.	Sex and Age	Chief Complaint	Tumor of the Iliac Fossa	Posterior Swelling	Flexion Adduction Internal Rotation Deformity	Sciatic Pain	Fever Controlled	Operation Performed		Conservative Treatment	Results
								Anterior Approach	Posterior Approach		
1	Male 19	Pain in back	Yes	No	No	Yes	Yes	Yes			Cured
2	Male 19	Pain in back	Yes	No	No	Yes	Yes	Yes			Cured
3	Female 30	Pain in back	No	Yes	Yes	Yes	No		Yes		Cured
4	Female 17	Pain in back	Yes (very small)	No	No	Yes	Yes			Yes	Cured
5	Female 9	Pain in back, inability to walk	Yes	Yes	Yes	Yes	No	Yes			Cured
6	Male 37	Pain in back, limp	Yes	No	Yes	Yes	Yes			Yes	Cured
7	Male 9	Pain in back, fever	Yes	No	Yes	Yes	Yes			Yes	Cured
Total		7	6	2	4	7	5	3	1	3	7

Due to the peculiar anatomy of the joint, a posterior approach will not drain an anterior abscess, and *vice versa*. In this small series of seven cases, the abscess formed anteriorly in six patients.

The author has found a new anterior approach valuable.

The author is indebted to Don E. King, M.D., of Stanford University Hospital, San Francisco, California, for the correction and sound criticism of this article.

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INTERINNOMINO-ABDOMINAL (HIND-QUARTER) AMPUTATION

BY SETH SELIG, M.D., F.A.C.S., NEW YORK, N. Y.

Billroth, in 1891, performed the earliest recorded interinnomino-abdominal amputation, but the patient survived only a few hours. Since then, a considerable number of successful cases have been reported in the English, French, German, and Russian literature. Gordon-Taylor, a British surgeon, reported the amazing total of eleven cases with four deaths. However, only two successful cases (surviving a week or longer) have been reported from this country.

CASE REPORT

J. J., a male Puerto Rican, aged twenty, was admitted on January 24, 1940, to the author's Service at the Mount Sinai Hospital, because of pain and swelling of the left hip region of three weeks' duration. General physical examination was negative except for a few small shotty lymph nodes in both inguinal regions, limitation of motion of the left hip joint in all directions, and a tender, semifluctuant mass about the size of an orange over the greater trochanter. The temperature ranged between 100 and 104 degrees, and any movement of the hip caused agonizing pain. Aspiration of the mass was unsuccessful. The tuberculin test and the Wassermann test were negative, and the urine showed no pathologically formed or chemical elements. The blood count revealed a hemoglobin of 87 per cent. with a red-cell count of over 5,000,000. The sedimentation rate was rapid. Roentgenographic examination of the hip, the pelvis, and the lungs failed to reveal any abnormalities.

On February 7, an incision was made over the greater trochanter and a large amount of gray, necrotic, semifluid tissue was obtained. In addition, specimens were removed from the wall of the cavity. Because no roentgenographic evidence of bone involvement was noted, the pathologist reached the conclusion that the tumor was a round-cell sarcoma, possibly of synovial origin (Fig. 1). The roentgenotherapist was then called in consultation, and after examining the patient and the specimen, he stated that synovial sarcomata were not radiosensitive, and that even if roentgenotherapy were desired, it should be delayed until the wound had healed. At that time, the wound was gaping and the neoplasm had begun to protrude from the wound. The condition of the patient was pitiable. Because of the desperate situation, and because roentgenograms of his lungs and bone structure failed to reveal any evidence of metastases, it was felt that the patient should be subjected to a hind-quarter amputation.

On February 23, 1940, spinal anaesthesia was administered, using 120 milligrams of neocaine. In spite of the fact that the spinal anaesthesia was smoothly given, it was not effective, and it was necessary to use supplementary gas-oxygen-ether anaesthesia. An intravenous drip of saline was started before the incision was made, and blood was available for a continuous transfusion during the operation. The patient was placed in the supine position, but the left lower extremity was draped in such a fashion that he could be turned onto his right side without disturbing the drapes. The surface of the biopsy wound, which was obviously infected and through which the neoplasm was beginning to bulge, was thoroughly cauterized with the actual cautery. The author had the able assistance of Dr. R. Colp during the entire procedure, particularly in dealing with the structures about the inguinal ring and Poupart's ligament.

The incision followed closely the description given by Pringle, which in turn resembled the incision of Girard except that no mesial flap was planned. The incision began at the mesial aspect of the thigh about one inch distal to the crural-scrotal fold,

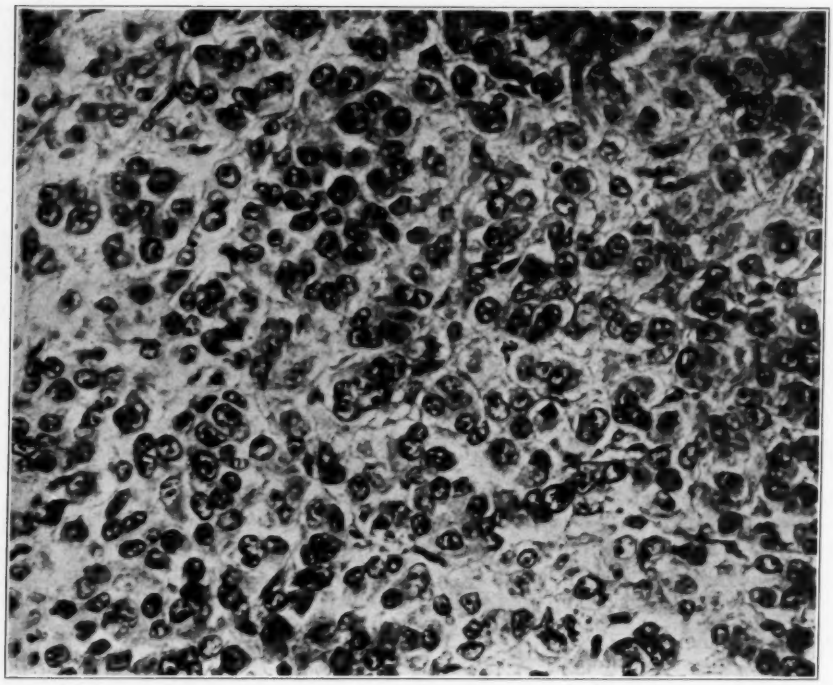

FIG. 1

High-power photomicrograph of the neoplasm (endothelial myeloma).

and continued anteriorly about one inch below Poupart's ligament, gradually approaching Poupart's ligament until the incision reached the anterior superior spine of the ilium. Poupart's ligament was cut laterally where it takes origin from the ilium, and both it and Gimbernat's ligament were severed mesially, and the spermatic cord was retracted mesially. The rectus abdominis muscle was cut close to the pubic bone, and the transversalis fascia enclosing the abdominal contents was pushed upward. During these steps the superficial and inferior epigastric vessels and the circumflex iliac vessels were severed, readily clamped, and ligated. The upward displacement of the abdominal contents proved surprisingly easy because the proper plane had been reached. The ureter remained with the peritoneum and was not seen during the operation. After isolating the external iliac artery, the external iliac vein, and the femoral nerve, they were doubly ligated with heavy silk, and cut across. During the operation, the three large nerve trunks which were severed, were all ligated before section. This was done to prevent bleeding from the arteries that course with or along the nerve trunk. In the case of the sciatic nerve, alcohol was injected before section. The transversalis fascia with the abdominal contents could now be pushed further upward, exposing the lateral wall of the pelvis. At this point the obturator artery and nerve could be seen along the lateral wall of the pelvis in their course to the obturator foramen. The vessel and nerve were doubly ligated, and cut. The bladder, with its surrounding fat, was pushed toward the right side, away from the symphysis pubis, and the cartilaginous symphysis was easily cut through with a scalpel. During this procedure, the bladder was protected by the author's hand.

The patient was then turned on his right side, and the incision was continued along the iliac crest, to the posterior superior spine of the ilium, and from the posterior superior spine of the ilium to the gluteal fold, and along the gluteal fold to the perineum where it met the beginning of the incision which had been made when the patient was

supine. On cutting through the gluteus maximus, the uppermost portion of the neoplasm was incised. The instruments were changed, and the incision was made at a higher level to completely circumscribe the tumor. The incision was carried to the bone through the gluteus maximus, and then carried along the posterior margin of the ilium. The superior gluteal artery was carefully watched for, doubly ligated, and cut. This is a large vessel which can cause a fatal hemorrhage if it is cut and permitted to retract into the pelvis. Anterior to the gluteus maximus, the sciatic nerve and inferior gluteal (sciatic) artery were exposed, doubly ligated, and cut, after the nerve had been injected with one cubic centimeter of absolute alcohol. The internal pudic artery was exposed, tied, and cut where it crossed over the spine of the ischium after leaving the pelvis. The sacrospinous and sacrotuberous ligaments were cut with slight bleeding. The coccygeus and levator ani muscles were cut, and the soft parts were then stripped from the rami of the pubis and ischium, care being taken to keep close to the bone. No bleeding at all was encountered during this last step, because the internal pudic artery had been tied. Commencing near the posterior superior spine of the ilium and sawing downward into the great sacrosciatic notch, the iliac bone was then sawed through, close to the sacrum. This is much simpler than attempting to disarticulate the sacro-iliac joint. The pelvis was then connected to the body only by the psoas muscle which, after ligation, was cut through just above the pelvic brim.

FIG. 2

Coronal section through the hip joint, showing the relationships of the neoplasm to the surrounding structures.

The wound was closed by heavy tension mattress sutures of silk. No attempt was made to close the wound layer by layer, as the patient's condition was giving concern at that time, and speed was necessary. Two rubber-dam drains and two packings were inserted at the upper and lower angles of the wound, and a compression gauze dressing was applied. The total operating time was ninety-five minutes.

Attention should be called to the fact that the internal iliac artery was not tied, but merely the important branches as they came into view. It has been noted that if both the internal and external iliac arteries are ligated, there may be necrosis of the flaps. With this procedure, there was surprisingly little bleeding. A continuous intra-

FIG. 3

Postoperative photograph of the patient, showing the healed anterior part of the wound, and the large granulating posterior portion.

venous infusion of citrated blood was given, and during the operation and immediately afterward the patient received 1200 cubic centimeters of blood.

After the operation had been finished and the anaesthesia was stopped, the patient rapidly regained consciousness, but it was deemed unwise to remove him from the operating table immediately, and he was left on the table in the Trendelenburg position. At 11:45 in the morning—that is one hour and a half after the conclusion of the operation—the patient's blood pressure was about 106, and his condition appeared satisfactory. A bed was then moved into the operating room, and the patient was carefully lifted from the operating table into the bed. Immediately, his condition underwent a dramatic change. He became exceedingly pale, his pulse became imperceptible, and his blood pressure fell to fifty-five systolic. He was given an additional 300 cubic centimeters of blood, and the foot of the bed was raised to combat the shock. He was given ten milligrams of desoxycorticosterone intramuscularly, and six minims of adrenalin intravenously. Within a few minutes, his systolic blood pressure rose to 170, but quickly fell to 128, at approximately which point it remained for the rest of the day. The bed was wheeled to the ward with the foot elevated, so that at no time was the Trendelenburg position lost. From that point on, the patient's condition rapidly improved, and he voided spontaneously the night of the operation.

The specimen proved most interesting. The growth had perforated through the iliac bone into the pelvis and lifted up the iliacus muscle. At one point the fibers and the muscles were pushed apart by the growth. The deep inguinal nodes were enlarged to the size of a plum. On section they were soft and yellowish gray in color. The superficial inguinal nodes were only moderately enlarged, and had a similar appearance on section. The gluteal muscles were also lifted up by that portion of the tumor which arose from the lateral aspect of the ilium. Upon coronal section (Fig. 2) through the ilium, hip joint, and femur, the relationship of the tumor to the surrounding structures could be noted. The tumor measured fifteen centimeters in its longest diameter.

FIG. 4

Postoperative roentgenogram of the patient, showing the small segment of ilium, remaining after amputation.

The tumor was also firmly fixed to the external and uppermost aspect of the capsule of the hip joint. The pathological diagnosis of the resected specimen (Fig. 1) was an endothelial myeloma (Ewing's tumor). This diagnosis was not made from the original biopsy specimen, because no bone origin or involvement of this huge growth was discernible on the roentgenograms. Had the author been aware of the true diagnosis before operation, he would have advised roentgenotherapy, rather than the radical operation.

In a few days after the operation the patient's morale rose, because he had been relieved of the severe pain. He developed a mild infection in the wound, which responded to sulfanilamide. There was some gaping of the skin and sloughing of the fascia, but the deeper structures healed well (Figs. 3 and 4). There was no evidence of herniation through the wound. (Keen mentions the theoretical danger of hernia, but the strong transversalis fascia is sufficient to prevent herniation of the abdominal contents.) Healthy granulation tissue appeared in the wound, and epithelization of the edges progressed rapidly. Some difficulty in spontaneous bowel movements was encountered, and daily enemas were necessary.

After several weeks, a change was noted in the patient's condition. He lost weight and strength, his appetite decreased, and a gradual recurrence of pain was noted. His subsequent course was rapidly downhill, and multiple metastases developed to the lungs, pleura, and liver, as well as lymph nodes, and a local recurrence at the operative site. Roentgenotherapy failed to halt the progress of the neoplasm.

The patient died forty-five days after the operation, and autopsy revealed the multiple metastases noted above.

The extreme rapidity in development of the metastases where none had previously been noted by careful roentgenographic examination makes one wonder whether the operation itself may have hastened their development.

The operation is a multilating one, and it is attended by a high mortality, but it should be attempted in cases presenting a radioresistant neoplasm about the hip joint, too high for disarticulation. Of course, a careful preoperative examination must be made by clinical and roentgenographic means to rule out the presence of metastases.

The operation has also been advised for uncontrollable chronic infections about the hip joint and dissecting aneurysms of the femoral artery.

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CARPAL BOSS: A COMMONLY OVERLOOKED DEFORMITY OF THE CARPUS *

BY RALPH M. CARTER, M.D., GREEN BAY, WISCONSIN

About five years ago, there came under the author's observation a patient presenting an unusual deformity of the wrist. The history follows:

CASE 1. The patient, a single woman, thirty years of age, was a trained nurse by occupation. Several months previous to examination, she had noticed on the posterior aspect of her right wrist a small, hard growth, apparently of bone, which had gradually been increasing in size. So far as she knew, there had been no antecedent injury. She complained of only two symptoms: The hand tired rather more easily than normally, and there was an occasional sensation as though an extensor tendon had caught over the tumor, and immediately slipped off with a definite jerk.

The general physical examination was negative. Upon inspection of the wrist, there was to be seen, upon the posterior aspect, a definite rounded tumor. This tumor, situated at the base of the third metacarpal bone, was firm in consistency, was painless upon pressure, and was apparently firmly attached to the underlying bone. The skin was freely movable above it. The tumor was approximately one centimeter in diameter, and was much more apparent with the hand in extreme palmar flexion (Fig. 1-A).

A lateral roentgenogram showed that the tumor was a definite outgrowth of bone posteriorly from the distal articular surface of the os capitatum of the wrist, and a similar outgrowth from the proximal articular surface of the third metacarpal; in other words, there seemed to be a fully developed posterior "lipping" of the articular surfaces of both bones, with complete preservation of the articulation itself (Fig. 1-B).

At that time the author was unfamiliar with the condition as a clinical entity, and he considered it an unusual osteo-arthritic manifestation, similar to the spur formation which is not infrequently seen at the metatarsophalangeal joint of the great toe. In view of the fact that the interference with tendon function was annoying, the patient desired treatment, and removal of the bone spurs was suggested. At operation, the condi-

FIG. 1-A

External appearance of deformity with wrist in palmar flexion.

* Presented before the Chicago Orthopaedic Society, Chicago, Illinois, February 14, 1941.

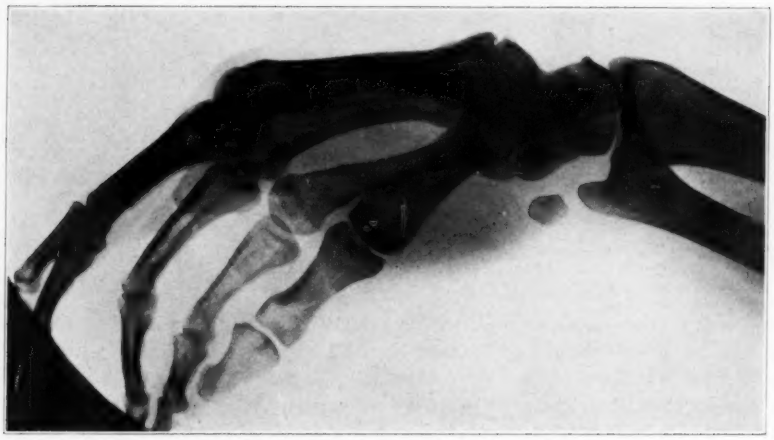

FIG. 1-B

Roentgenogram showing bone bosses at articulation of the third metacarpal and the capitate bone of the wrist.

tion was found to be as was shown in the roentgenograms. The spurs were removed, and the symptoms disappeared. Within a few months, the tumor had reappeared, and the roentgenogram revealed that the preoperative condition had recurred. However, there has been no recurrence of symptoms, and the tumor, having again attained its original dimensions, has since shown no tendency to increase in size.

A few months later, a second patient was seen, with a condition similar in every respect to the first one, so far as physical and roentgenographic examinations disclosed.

CASE 2. A male laborer, thirty-five years of age, had a tumor which had gradually developed, following a moderate blow on the posterior aspect of the wrist, two or three months previous to consultation. Symptoms were almost entirely absent, although the patient stated that after a hard day at work, the wrist occasionally ached, and that the wrist and hand seemed to tire more readily than formerly. In view of the experience with the first case, surgical removal of the bone tumor was advised against, because a recurrence appeared to be a likely possibility. The patient, however, was insistent that removal be tried. This was done, but within a comparatively short time, complete recurrence had taken place. This was a compensation case, and it was closed by the payment of a nominal sum for possible permanent disability.

Since then, four additional patients have come under observation. Of these four, one was a stenographer, one was a laborer, and two were housewives.

The stenographer complained of the usual mild symptoms of occasional aching and easy fatigability of the wrist.

In the case of the laborer, the finding was an incidental one in the course of a general physical examination. So far as he knew, the tumor of the wrist had been present for several years, and had given him no trouble of any kind; therefore he had not sought treatment.

One of the housewives presented herself because of a large bursa

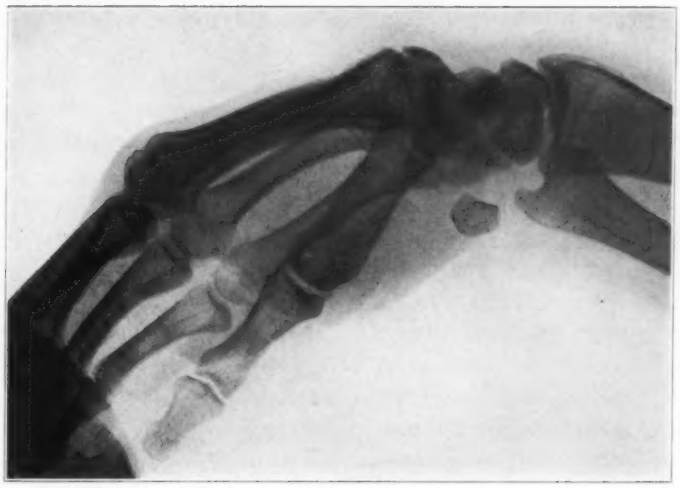

FIG. 2

Roentgenogram showing outline of bursa which had developed over the deformity.

which had developed over the bone tumor, the latter being discovered when a roentgenogram of the wrist was made (Fig. 2). Removal of the bursa was suggested, but she did not return for treatment.

The last patient, a housewife, came to examination because of the tumor, associated with the usual mild subjective symptoms. She, likewise, did not return, probably because no assurance of success in treatment could be given.

Investigation of the literature revealed the fact that the condition which has just been described constitutes a definite clinical entity, but one which, so far as the author is able to determine, has been described only in the French medical literature, under the name of "*carpe bossu*", a term which may be literally translated as "bossy wrist" or "carpal boss", using the word "boss" in the sense of a protuberance of bone. No reference to it could be found after a careful search through a number of standard works on orthopaedic surgery and roentgenographic diagnosis, nor could any references to it, other than the articles noted below, be found in the Quarterly Cumulative Index or Quarterly Cumulative Index Medicus from 1920 to the present time.

So far as the author has been able to find, the first case was reported by Fiolle in 1931. Several other articles on the subject followed this first publication, and additional cases were reported by Fiolle and Ailland, Mouchet, Fiolle and Coudray, Chavannaz, Roederer and Charry, Imbert, and Menegaux, the last-named author reporting two cases.

The total number of cases reported in the articles above mentioned is nine; the author's six cases bring the total on record to fifteen. However, the author believes that the condition is much more common than these figures would indicate.

The physical and roentgenographic findings are typical, and are well presented by the cases here shown.

As a rule, symptoms are slight or absent, and the condition, aside from the cosmetic defect, is apparently of little moment. However, as in one or two of the author's cases, and in the two cases reported by Menegaux, mild disability may occasionally be present.

The etiology is unknown, and no cases are reported which would lead to the belief that it may be a congenital condition. Fiolle believes that it may be a syndrome analogous to the lesions of the Mouchet-Köhler type. The opinion has been expressed that the exostoses may be the result of an early fracture. The author is unable to find any evidence, either in the reported cases or in his own, which would lend support to either of these views. Mouchet interprets it as a sequel of a sprain. Tavernier, quoted by Fiolle and Ailland, asks if it may not be an effort deformity, resulting from an occupation requiring repeated pressure from below upwards on the index and middle fingers, thus tending to force the metacarpals on the wrist bones. Menegaux feels that it is entirely possible that the condition may have a traumatic origin. The genesis from trauma is explained as follows: The initial traumatism gives rise to a slight carpometacarpal sprain, with rupture or slight tearing of the dorsal ligament between the capitate bone and the third metacarpal. Then, little by little, a constantly repeated movement of the fingers, by pulling or pressing upon the already slightly traumatized region, will give rise to an ossifying reaction beneath the affected ligament. There will thus be produced the slow formation of the carpal and metacarpal bosses, which will naturally not attract attention until they have become somewhat definitely developed.

Obviously, all of these assigned causes are speculative, and the condition has not been sufficiently studied to prove or disprove any of them. The fact that the deformity always occurs in the same location, and always presents the same roentgenographic appearance, would indicate that some etiological factor is present which is common to all; *a priori*, it would appear extremely likely that this common factor might be an occupational one. However, when the occupations in the reported cases are studied, the question is not answered. Three cases occurred in manual laborers, in one of whom the condition was bilateral; one in a trained nurse, two in stenographers, one in a seamstress, two in housewives, one in a wood carver, and two in surgeons. In three cases, the occupations were not given. Certainly, these occupations would seem to have nothing in common, unless it be the frequently repeated finer movements of the fingers, and this would not apply to manual labor. Furthermore, if such a cause were really active in the production of the condition, the deformity should be found very frequently in typists, in piano players, and in musicians playing other instruments. That the cause which originally produced it in the first case seen by the author probably remained active, is shown by the fact that the exostoses promptly recurred after removal.

A brief report of these cases was presented at a recent orthopaedic meeting *. During the discussion which followed, it was brought out that several of the surgeons present had seen one or two cases; for this reason, it is felt that the condition occurs more frequently than a study of the literature would indicate.

In connection with the question of treatment, one surgeon expressed the opinion that the condition represented an osteo-arthritis of the affected joint, and that removal would be entirely successful and not followed by recurrence if the wrist were immobilized in plaster for a few weeks following operation. Immobilization following operation is an interesting suggestion and worthy of trial. The author did not use it with the two patients upon whom he operated, and it is not mentioned in any of the reported cases. The suggestion that the condition may be an osteo-arthritic manifestation is open to considerable doubt. At operation, these bone bosses do not resemble osteophytes or lipping of the articular margin in any way, but seem to be an actual overgrowth of normal bone in the affected area. No histological studies of the removed bone have been made.

Further, in connection with the operative treatment, Lambert, of Chicago, stated that he had seen one case, also in a trained nurse. The bosses were removed by operation, and promptly recurred; they were removed a second time, and recurrence again took place. The condition at present remains as it was previous to the first operation.

Two considerations prompted the preparation of this report. In the first place, the disease is of interest from an academic standpoint. It is apparently a sharply defined clinical entity, and probably more common than a search of the literature would indicate. Even though it is a comparatively trivial affection, orthopaedic surgeons should have it in mind and be able to recognize it when it presents itself, if only for the purpose of differential diagnosis.

In the second place, and probably of more importance from a practical standpoint, is the fact that disability claims may arise following industrial accidents, as in one of the author's patients. In the published cases, and in his own limited experience, there is nothing to indicate that the condition follows a single trauma of the affected region. On the contrary, it appears to be a gradual development. If a single trauma were the etiological factor, it would seem that the disease would be frequently seen by traumatic surgeons, because contusions of the hands and sprains of the wrist are extremely common, but apparently such is not the case. In the one case seen by the author, in which there was a history of trauma, he is not at all sure that the boss was not present preceding the alleged trauma. Therefore, when such claims are made, the history should be investigated with extreme care.

Apparently these patients should not be operated upon.

* Clinical Orthopaedic Society, Milwaukee, Wisconsin, October 15, 1940.

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HISTOLOGICAL STUDY OF A TRANSCERVICAL FRACTURE OF THE FEMUR AFTER INTERNAL FIXATION

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From The Fracture Service of Knickerbocker Hospital, New York

Concentration on methods and appliances for internal fixation of transcervical fractures of the femur has almost completely excluded consideration of the basic histological changes taking place as a result of such fixation. A few pathological reports have appeared in the literature—Palmer in 1934, Jones and Lieberman in 1938, Felsenreich in 1939, Engel in 1940, and Kulowski and Luck in 1941—but, because there are many unexplained factors in the success or failure of this relatively new form of treatment, there is need for continued histological study.

It is the purpose of this paper to report the late microscopic findings in a transcervical fracture of the femur fixed with a vitallium Smith-Petersen nail. The specimen was obtained from the patient thirteen months after operation, when firm bony union, allowing unsupported weight-bearing, had developed. Death was due to carcinoma of the cervix. At no time, either before the fracture occurred or after operation, was there metastasis to the femur or any other bone.

The following brief summary gives the essential clinical features of the case.

CASE REPORT

M. B., a woman, aged fifty-nine years, was admitted to Knickerbocker Hospital on June 16, 1939, with the typical physical and roentgenographic findings of an acute transcervical fracture of the right femur. The leg was placed in Russell traction, and on June 23, 1939, under nitrous-oxide-ether anaesthesia, a vitallium Smith-Petersen nail three and three-quarters of an inch long was inserted through a lateral incision.

The postoperative course was smooth, and the patient was up in a wheel chair on the third day. Because of vaginal bleeding, which developed during convalescence, a biopsy of the cervix was taken, and this showed epidermoid carcinoma. The patient was discharged on July 29, 1939, and referred for radium treatment.

Her fracture progressed satisfactorily, and in March 1940, nine months after operation, she walked without support, had a painless hip with full range of motion, and showed roentgenographic evidence of bony union. However, intra-abdominal metastasis from the cervical carcinoma developed, and she was admitted to the Home for Incurables, where she died on July 31, 1940, thirteen months after the insertion of the nail. The proximal end of the right femur was removed three hours after death.

Gross Pathology

The specimen consisted of the proximal five inches of the right femur, transfixed with a Smith-Petersen nail (Fig. 1). There was solid bony union. The articular cartilage of the head, and the ligamentous attachments at the greater and lesser trochanters were dark brown in color. The nail emerged from the center of the lateral surface of the shaft three centimeters below the base of the greater trochanter, and could be removed and reinserted, gliding inward and outward as a smooth key in a keyhole. The nail was removed, and a horizontal section cut through the center of the head, neck, and shaft.

The outstanding feature of the horizontal section was the glistening, smooth-sur-

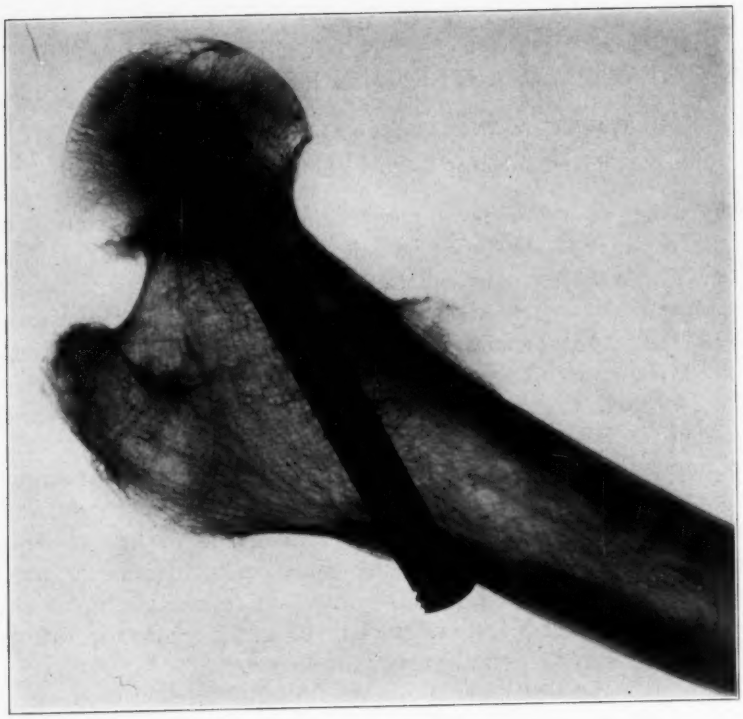

FIG. 2
Roentgenogram of the specimen.

FIG. 1
Photograph of the specimen.

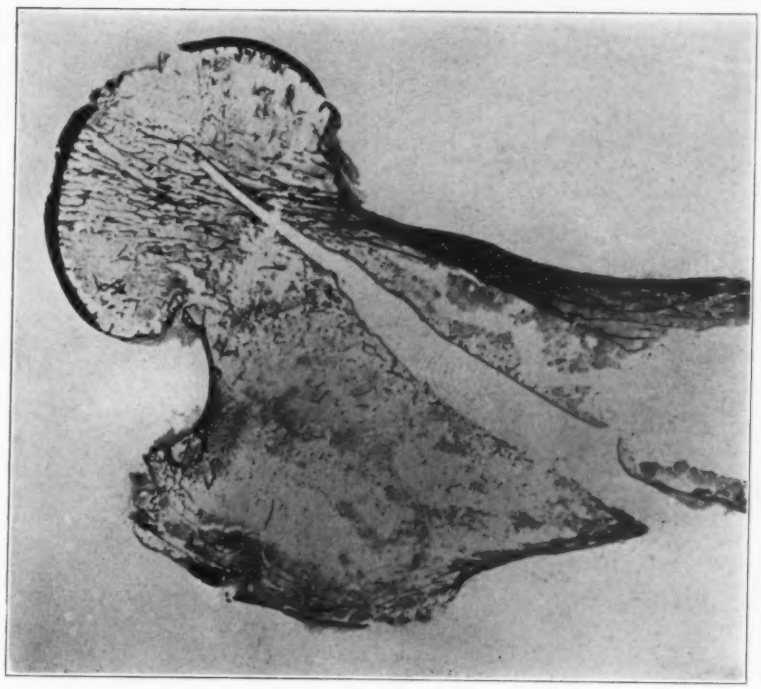

FIG. 4
Photograph of histological section of the specimen.

FIG. 3
Photograph of a horizontal section of the specimen. Note the glistening membrane lining the nail tract.

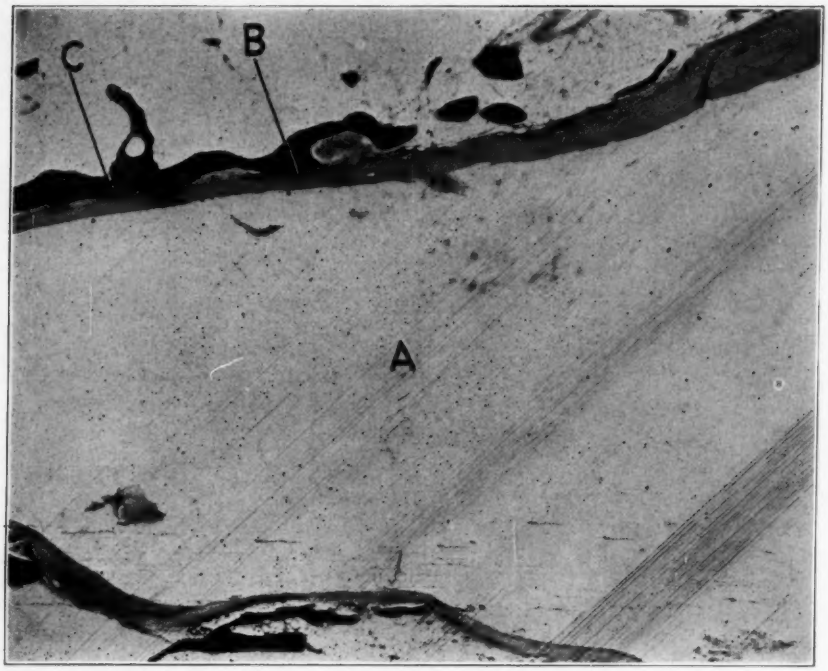

FIG. 5

Photomicrograph (× 28) of section through nail tract. *A* = Nail canal; *B* = Connective-tissue layer of membrane; and *C* = Bone layer of membrane.

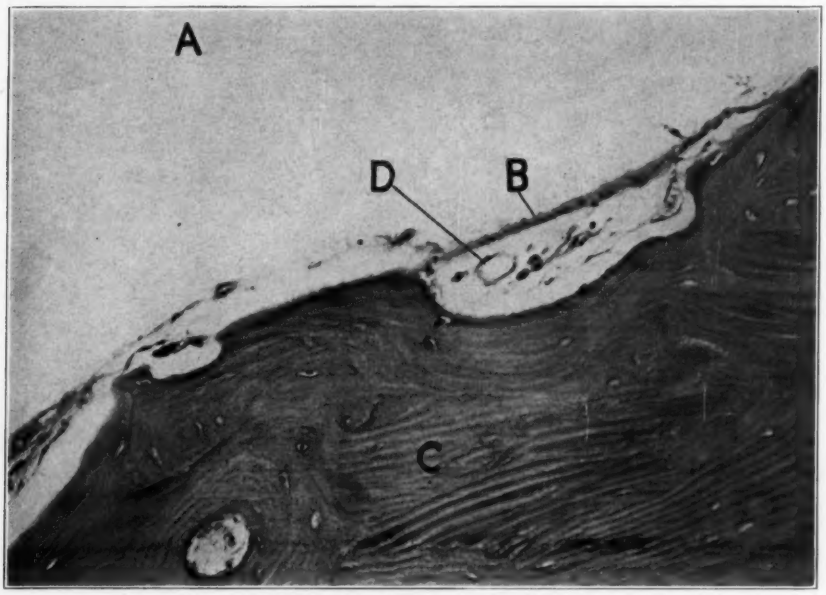

FIG. 6

Photomicrograph (× 180) of nail-canal membrane, showing one of its blood vessels. *A* = Nail canal; *B* = Connective-tissue layer; *C* = Bone layer along nail canal; and *D* = Blood vessel in connective-tissue layer.

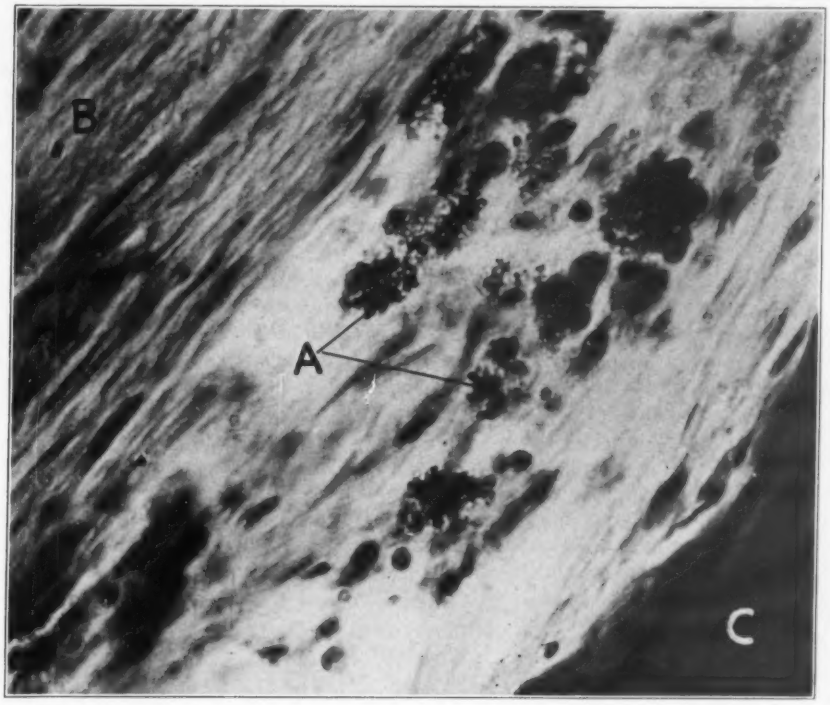

FIG. 7

Photomicrograph (× 800) of nail-canal membrane, showing pigment granules. *A* = Pigment granules in outer area of connective-tissue layer; *B* = Connective-tissue layer; and *C* = Bone layer.

faced, gray membrane which lined the nail tract throughout its entire course (Fig. 3). This membrane varied in thickness from two to three millimeters and was continuous with the adjacent bone structure. The fracture site was faintly visible and crossed the neck obliquely below the head. The head and neck showed no other gross changes. The periosteum of the neck was intact and on the shaft it dipped into the nail tract and was continuous with the lining membrane. The articular cartilage was smooth, of normal thickness, and, save for its deep brown pigmentation, showed no gross pathological changes.

Histological Study

A section of the entire specimen was made with celloidin technique, and stained with hematoxylin-eosin (Fig. 4). Smaller sections were studied with Mallory-Heidenhain and elastica van Gieson preparations.

The femoral head showed the presence of normal, living trabeculae. The nuclei of the bone cells stained, and did not suggest degeneration. As there were no necrotic trabeculae noted, this head evidently had not undergone aseptic necrosis. The articular cartilage of the head was smooth, of normal thickness, and was well preserved. It was deeply pigmented, and by special stain this pigment was shown to be iron. The cartilage cells appeared viable.

The neck showed marked subperiosteal bone formation at its inferior aspect. In the region of the fracture site there were bone trabeculae which appeared to be of recent development. In these areas of recent bone development, there were fragments of original trabeculae along some of which were rows of osteoblasts.

The Nail Tract

A most interesting feature of the section was the membrane lining the nail tract. This membrane varied in thickness at different levels, was continuous with the periosteum of the shaft, and completely lined the nail bed. It consisted of two well-defined layers: (1) an inner layer of connective tissue, and (2) an outer layer of bone trabeculae (Fig. 5).

The layer of connective tissue was composed of fibroblasts which were arranged parallel to the nail, and were continuous with the connective-tissue elements of the adjacent marrow. Numerous blood vessels were present in the outer section of this layer, and in the spaces between it and the surrounding bone lamellae (Fig. 6). These vessels were of particular interest and could be seen at various points along the nail tract. At the outer margin of this connective-tissue layer, groups of small, deeply stained pigment granules were seen. Some of these granules appeared to lie within macrophages, others were extracellular, lying in clusters between the fibroblasts. These granules were present only adjacent to the trabeculae or spongiosa, never near the nail. By special stain the pigment was shown to be iron (Fig. 7).

The bone layer consisted of trabeculae laid down along the nail tract. The bone trabeculae did not surround the tract throughout its entire length, there being intervals where the fibrous tissue layer was in contact with the spongiosa with no intervening lamellae. However, in the region of the head, the osseous layer was present as an envelope surrounding this portion of the nail tract. Typical of the bone layer were trabeculae situated at right angles to the tract. There were some areas in this layer in which there had been an ingrowth from the fibrous-tissue layer, and which may have represented fibrous absorption of the bone trabeculae. These areas, however, were few.

DISCUSSION

The pigment granules and surrounding cells along the nail tract have not been described in the cases reported in the English literature. However, Felsenreich described them in considerable detail, and they are considered a constant finding. They are known as "rust granulomata" and the statement is made that the pigment is a form of organic iron derived from the iron of the stainless-steel nail.

In the case here reported, the pigment is definitely iron; but, since a vitallium nail containing no iron was used, the pigment could not have come from the nail. It would seem that the iron pigment was derived from broken-down red blood cells, possibly resulting from the continued trauma of the nail forced against the surrounding trabeculae and marrow.

The presence of pigment in the capital cartilage and trochanters occurring in this case has not been previously reported, and is probably an unusual finding. It may be a phase of cartilage degeneration.

CONCLUSIONS

1. Because of the presence of massive bone lamellae along the nail tract, it can be stated with assurance that, contrary to former belief, certain metal alloys introduced into bone do not prevent bone formation.

2. The new blood vessels in the connective tissue of the nail tract seem to be an increased blood supply, and, when carried across the fracture site, may be a factor in the better nutrition of the head. This interpretation was first suggested by Engel.

3. The nail causes the development of a fibrous-tissue cavity of

considerable size, not unlike a bone cyst, which traverses the head and neck.

4. If the theory of the origin of the pigment granules is correct, the nail in its canal causes trauma to the surrounding spongiosa and bone lamellae.

The author wishes to thank Herbert Bergamini, M.D., C. Howard Hatcher, M.D., Henry Horn, M.D., and William C. Clarke, M.D., for their help in this case.

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TWO UNUSUAL INJURIES OF THE WRIST

BY VERNON L. HART, M.D., MINNEAPOLIS, MINNESOTA

The writer wishes to record two unusual injuries of the wrist resulting from direct violence over the volar aspect of the carpus.

The first injury is a fracture of the ridge of the greater multangular bone or trapezium which gives attachment to three of the intrinsic muscles of the hand and the transverse carpal ligament.

The patient's injury resulted from a fall upon the volar surface of the wrist, while he was going down a steel stairway, and was considered a sprained wrist since the routine roentgenograms were normal. Two weeks after the injury a vertical roentgenogram of the wrist was studied because severe pain and tenderness over the volar aspect of the greater multangular bone persisted. The roentgenogram (Fig. 1) demonstrated a fracture of the ridge of the greater multangular bone which forms part of the radial border of the carpal canal. Adequate immobilization of the wrist, limited use of the hand at work, and frequent warm hand baths resulted in normal return of function after several more weeks.

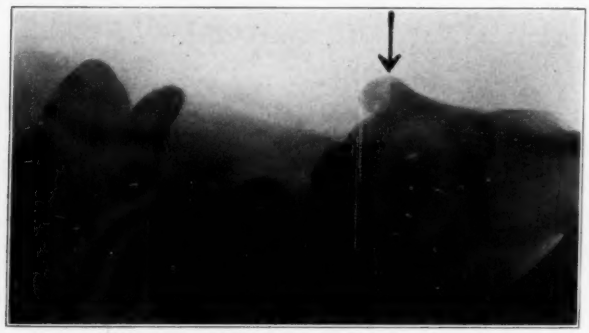

FIG. 1

Vertical roentgenogram of the wrist, revealing a fracture of the ridge or tuberosity of the greater multangular or trapezium bone which forms part of the radial border of the carpal canal.

The second injury is a scar-tissue, ring constricture of the ulnar nerve where it passes over the hook of the hamate or unciform bone which forms a part of the ulnar border of the carpal canal (Fig. 2).

FIG. 2

Vertical roentgenogram of the wrist demonstrating the bones of the carpus, which form the borders of the carpal canal, and the relationship between the ulnar nerve and the hook of the hamate or unciform bone and the pisiform bone. The ulnar nerve (indicated by white circle) crosses over the tip of the hook of the hamate bone and, in the normal hand, can be felt slipping over the bone when pressure is made with the thumb of the opposite hand about two centimeters distal and radial to the pisiform bone.

The volar aspect of the patient's wrist was injured when a barrel weighing several hundred pounds rolled upon it. The injury was considered

to be a sprained wrist for a period of seven months. During this time the patient could not work because of great pain and tenderness in the region of the hypothenar eminence. Several physicians had treated the patient, and many routine roentgenograms were normal. Possible diagnoses of neurosis and malingering were also considered. No relief of symptoms was obtained by immobilization and physical therapy. Pressure applied directly over the hook of the hamate bone and the ulnar nerve, or a finger's breadth distal and radial to the pisiform bone, caused severe local pain and radiating pain into the fourth and fifth fingers. There was moderate, but definite swelling of the hypothenar eminence, and hypaesthesia over the distribution of the superficial branch of the ulnar nerve to the fourth and fifth fingers.

The volar branch of the ulnar nerve crosses the transverse carpal ligament on the radial side of the pisiform bone, and ends by dividing into a superficial and a deep branch. The superficial branch is purely cutaneous and supplies the skin on the ulnar side of the hand, the palmar aspect of the fifth finger, and the palmar surface of the ulnar half of the fourth finger. The deep branch is purely motor.

Under local anaesthesia the ulnar nerve was exposed directly over the prominent hook of the hamate bone. (At this level the ulnar nerve divides into the deep and superficial branches.) Immediately distal to the division there was a marked constriction of the superficial branch of the nerve caused by a thick ring of scar tissue which was adherent to the free end of the hook of the hamate bone. The nerve was oedematous and swollen directly proximal to the constriction. Excision of the ring of scar tissue and a neurolysis of the affected portion of the nerve resulted in complete relief of the patient's disability.

ROENTGENOGRAPHIC RECOGNITION OF SYNOVIOMA

BY A. P. AITKEN, M.D., BOSTON, MASSACHUSETTS

Within the past few years, there has been described in the literature the rather uncommon tumor known as synovioma. Unfortunately this term has been applied to all forms of intracapsular tumors, either benign or malignant, notably the more common xanthoma. The tumor to which the author refers, however, is one derived primarily from the cells of the synovial lining, and characterized by the formation within the tumor of spaces lined with synovial cells. The tumor is said by pathologists to resemble closely an angioma, and to be often mistaken for it. This neoplasm is a sarcoma, and is either highly malignant or potentially so. Although the tumor is derived from synovial cells, and may thus arise from either a joint or a bursa, it may be found to be entirely extracapsular, and to have no apparent association with either of these structures. However, it is usually found in close proximity to a joint. Clinically, this neoplasm is seldom diagnosed prior to biopsy and microscopic study. When a soft-tissue tumor mass develops in the neighborhood of a joint, the diagnosis is usually one of the benign tumors—such as lipoma, fibroma, or cyst of the semilunar cartilage or bursa. When such masses show calcification, the most common diagnosis is that of a calcified bursa. That such a mass may be highly malignant, or potentially so, is not even suspected, in most instances. Any evidence, then, which might be of aid in the diagnosis of this tumor, is of great value.

In a recent article, Lewis [1] has described roentgenographic evidence which he believes is pathognomonic of this tumor. Although this evidence was present in only 25 per cent. of his cases, the author believes it should be called to the attention of the orthopaedic surgeon. Lewis states, "Near a joint, and sometimes involving the joint, is seen a rounded, sometimes rather lobulated, sharply defined, soft-tissue tumor mass. No differential diagnosis can be made on such a mass in itself; but when in the mass is found a scattered and irregular deposit of amorphous lime, we have learned that a provisional diagnosis of synovioma is justified." The following case demonstrates clearly this roentgenographic evidence as described by Lewis.

G. R., aged twenty-one, entered the Lawrence Clinic, Lawrence, Massachusetts, in February 1940, complaining of a painful swelling on the lateral aspect of the right knee. Two years previously, while playing basketball, he had been kicked in this region. The knee became acutely swollen and painful. After a few days of rest the pain disappeared, and the swelling largely subsided. Since this accident, however, a mass the size of a quarter had remained. This mass was painless until six weeks prior to admission. The boy stated that, since the onset of pain, he thought the mass had grown slightly larger. On examination a mass, the size of a plum, was found over the lateral aspect of the knee joint, just lateral to the patella. It was not tender, but it was soft, and portions of it seemed semifluctuant. The skin and subcutaneous tissues were freely movable over it, but the mass was firmly adherent to the capsule of the

FIG. 1-A

FIG. 1-B

Roentgenograms show amorphous areas of calcification in the anterolateral aspect of the knee joint with definite extension into the joint spaces as shown in the anteroposterior view. There is no evidence of bone involvement.

joint. There was a flexion deformity of 30 degrees, with considerable quadriceps atrophy. There was no free fluid present within the joint, and no capsular thickening was present elsewhere about the joint. The roentgenograms (Figs. 1-A and 1-B) revealed the mass, and within it a diffuse amorphous-lime deposit. This deposit clearly extended into the infrapatellar fat pad. The roentgenograms were shown to numerous roentgenologists and orthopaedic surgeons, but no definite diagnosis was made. It was thought that it might be a calcified hematoma, as the mass was noticed after definite trauma to this region.

At operation the tumor was found to be well encapsulated, was of grayish color, and very friable. On dissection laterally, however, the mass was found to have invaded the fascia lata. Medially the tumor was easily lifted off the tibia and lateral condyle of the femur. At the lateral border of the patella, however, the tumor extended into the infrapatellar fat pad, and here the synovial membrane was involved. The synovial membrane in this area was excised, and as traction was made on the mass on dissection, the whole tumor suddenly separated from the surrounding fat pad, showing a cylindrical mass of tumor, about one and one-half inches in length, which had extended through the fat pad to the medial side of the knee joint. This section apparently was also well encapsulated. Although the nature of the tumor was not recognized, its friability and tendency to invasion led to the belief that the tumor was malignant.

The tumor was first reported as an angioma. Dr. Beach Hazard, however, reported the mass as a malignant synovial sarcoma. His report is as follows:

"*Gross Examination:* The specimen consists of approximately four irregularly shaped masses of tissue received fixed in formalin. These measure up to three and five-tenths centimeters in diameter. On section they are found to be of white color, of rather firm consistency as received, and several present a few yellowish patches. One

fragment of tissue is a semilunar cartilage, along the margin of which is a somewhat blood-stained but otherwise grayish-white tissue.

"*Microscopical Examination:* The tissue masses are formed for the most part of small dark-staining cells of spindle shape, occasionally somewhat curved, which occur in rather broad sheets, present occasional pinkish hyaline zones, and with frequent zones of calcification. In addition to this picture there are occasional spaces, irregular in contour and with papillary projections extending into them at times, which are lined by epithelial-like cells of cuboidal or low columnar type. Many mitoses are present in some regions. A section through the semilunar cartilage shows the margins to be invaded by spindle-shaped cells as described.

"*Diagnosis:* Synovioma, with extensive calcification."

Because of the malignant nature of the tumor, amputation was advised, but refused. The boy was then seen once a month for seven months. During that time he had no pain and there was no evidence of recurrence either clinically or by roentgenograms. Four weeks after his last visit, in October 1940, the boy again returned complaining of pain. Examination at that time revealed the presence, in the scar, of three small tumor masses about one and one-half inches apart. There was no fluid in the knee joint, and the roentgenograms were negative. One week later, amputation at mid-thigh was performed. At that time not only had the three areas increased in size, but a fourth mass had made its appearance. Examination of the amputated knee showed numerous tumor masses within the joint, and several large masses in the popliteal space, two of which had extended well into the lumen of the popliteal vein.

Six months after amputation the boy was well, and there was no clinical or roentgenographic evidence of pulmonary metastasis, but on July 19, 1941, examination showed multiple metastases to the lungs.

SUMMARY

Synovioma or sarcoma of the synovial membrane is a rather rare form of tumor. Its occurrence is, however, being reported in the literature with increasing frequency. The diagnosis is seldom made clinically.

This case is presented to illustrate the roentgenographic appearance of this tumor as described by Lewis, and to call it to the attention of the orthopaedic surgeon.

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REMINISCENCES

Introductory Remarks at the Annual Meeting of the Orthopaedic Section of the Royal Society of Medicine *

BY ROYAL WHITMAN, M.D., NEW YORK, N. Y.

This Meeting enables me to establish what may be a record of active service, since there is an interval of sixty years between my first appointment, as an intern, and my last, as Consultant to the American Hospital in Britain.

Furthermore, as the only survivor of the first regular meeting of The American Orthopaedic Association, held in 1887, it will appear that my active life covers practically the entire period of the development of the specialty.

The term "orthopaedic surgery" was suggested by a New York surgeon, Valentine Mott, to signify the combination of operative and mechanical surgery, which, he predicted, would inaugurate a new era in the healing art,—a prediction that has been amply justified.

At this first meeting, the amalgamation of what until then had been antagonistic forces was far from complete. The President was an orthodox mechanician, permitting no operative treatment at the hospital that he controlled, because it would prevent the normal development of what he called "mechanico-therapy". He was a militant upholder of the traction treatment of hip disease, designed to permit motion without friction and thus to preserve the nutrition of the limb and to prevent ankylosis. He felt constrained, therefore, to use his influence to oust a colleague from his post at St. Luke's Hospital because he had been infected by the fixation heresy of Thomas.

At this meeting only a small contingent could qualify as orthopaedic surgeons. The outstanding representative of the new order was Dr. E. H. Bradford, whose son is now a member of the staff of this Hospital. He founded the Boston School, which has made so many valuable contributions to the development of the specialty.

The surgery of the period was purely corrective in scope. Constructive surgery was a later development. Constructive surgery implies the readjustment of the latent power of a disabled member to restore as far as may be its most important function,—primarily locomotion.

I think myself fortunate that, having had no instruction in the new departure, I was obliged to depend on my own observations and deductions. Thus unwittingly I followed the footsteps of John Hunter.

I had an unusual opportunity for self-education, for I worked for forty years in a hospital where the patients were not restricted by artificial

* A few months ago Dr. Whitman, who has resided in London for several years, was appointed Consulting Surgeon to the American Hospital in Britain, and these remarks are part of an address given at a meeting held at that Hospital on June 28, 1941.

conventions, combining in a continuous service both the out-patient and in-patient departments.

From this experience I came to the conclusion that the one who had analyzed the disability and planned the reconstructive procedure, who had carried it out according to specifications, and who by constant oversight had detected and supplemented its weak points was most competent to judge of its relative utility. These conclusions were so often at variance with what is called the consensus, that for the greater part of my active life I have been a member of the opposition.

Looking backward, I recall a dinner given by the Tavern Club to James Russell Lowell, lately returned from service at the Court of St. James, on his seventieth birthday, at which Oliver Wendell Holmes welcomed him to "life's fair field beyond the seven-barred gate". I continued in active work long after entering this enclosure, and I now find myself opposed to the statement of the Psalmist to the effect that those who reach eighty years can expect only labor and sorrow; for, since reaching this landmark, I have had the privilege of participating in the Battle of Britain, at least to the extent of having my windows broken. Moreover, I have received the great honor of election as Honorary Fellow of the Royal College of Surgeons and of the Royal Society of Medicine. This recognition of my work was the more appreciated because its foundation was laid in London, in the intensive study of anatomy in Cook's School, established in St. George's graveyard, and I am glad to have the opportunity to pay a belated tribute to the memory of the best teacher that I have ever known.

A SIMPLE APPLIANCE FOR THE CORRECTION OF GROSS DISPLACEMENT IN TIBIAL FRACTURES

BY H. K. CHRISTIE, M.CH.(N.Z.), F.R.C.S.(ENG.), F.R.A.C.S., WANGANUI, NEW ZEALAND

Major N.Z.M.C., Orthopaedic Surgeon to No. 1 N.Z. General Hospital, Middle East Force

The displacements which result from fractures of the long bones include shortening or overlap, lateral displacement, angulation, and rotation. All of these must be kept in mind to ensure accurate reduction and good functional repair.

These four deformities are to some extent interdependent, because angulation causes further shortening, while overlap is prone to cause "cross union" with the loss of movements of normal rotation. Shortening and angulation are of particular importance in the lower limb in relation to ambulation, and lateral displacement is a source of non-union.

Much ingenuity and unremitting care have been expended by orthopaedic surgeons in devising apparatus for the prevention and correction of such deformities, and, although a certain degree of standardization of methods has resulted, there is still room for improvement in these methods.

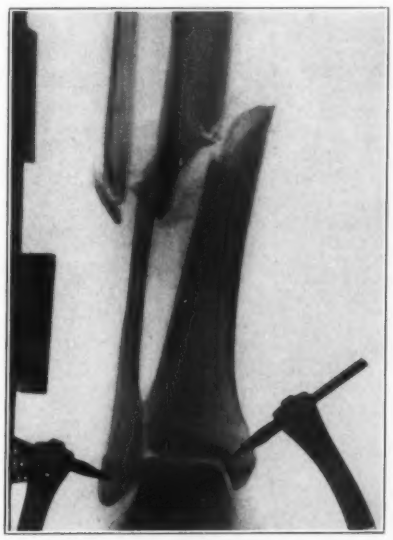

FIG. 1

Roentgenogram taken October 9, 1939, shows lateral displacement and overlap, and the presence of callus between the bone ends. The ice-tongs caliper has been placed too low.

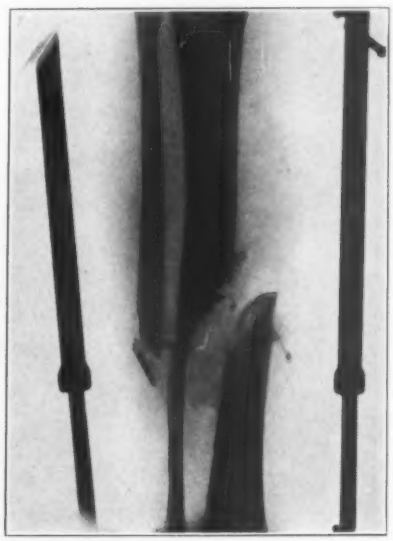

FIG. 2

Roentgenogram taken October 20, 1939. Steinmann pins have been inserted, and bone distractors of the Hey Groves type applied. Half the shortening was corrected at once, and the other half during the following week.

Much of the fracture apparatus in present use has certain disadvantages: (1) It is cumbersome and costly; (2) it is not self-contained (that is, it depends on weights and pulleys attached to frames and bedsteads); (3) it does not provide, in one apparatus, exact control of all three deformities and, at the same time, sufficient traction to correct fractures imperfectly aligned and already partly united.

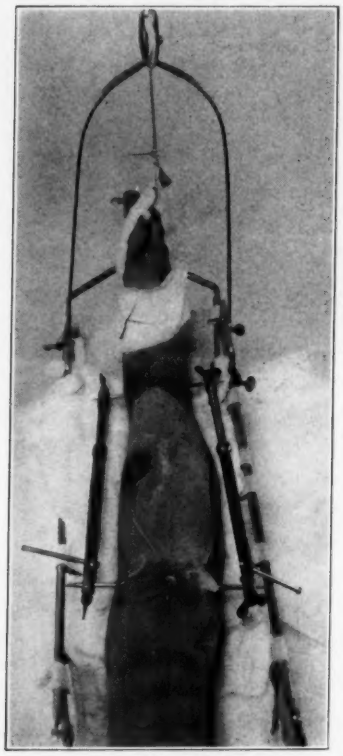

FIG. 3

In planning the apparatus used in the case here presented, it was the author's aim to overcome these defects as much as possible.

Case 1. On October 9, 1939, the patient was admitted to the Fracture Clinic of the Wanganui Hospital, New Zealand, four weeks after an accident, with unreduced compound comminuted fractures of the shafts of the tibia and fibula and gross shortening of one inch (2.5 centimeters), lateral displacement, and much callus separating the bone ends. An ice-tongs caliper was in position (Fig. 1).

It was necessary to provide powerful distraction of the fragments and lateral correction, in spite of the resistance of spongy callus.

FIG. 3

Showing use of distractors of the Hey Groves type for compound fracture with overlap and shortening.

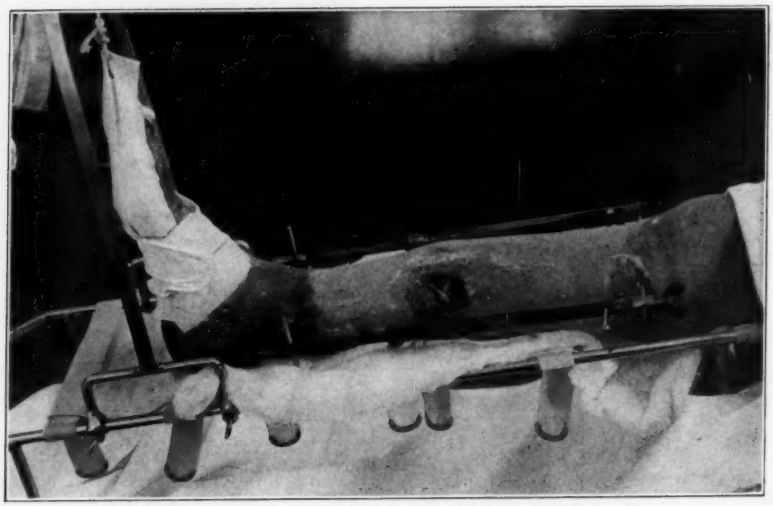

FIG. 4

Side view shows the Steinmann pins pushed apart by the lateral screws, thus correcting the shortening, but not the lateral displacement. Necrotic bone can be seen in the wound.

FIG. 5

November 1, 1939. Correction of the lateral displacement was obtained in spite of five weeks' callus, by the pressure of the shouldered pins. After correction, a close-fitting plaster was applied.

A sequestrum can be seen at the end of the lower fragment.

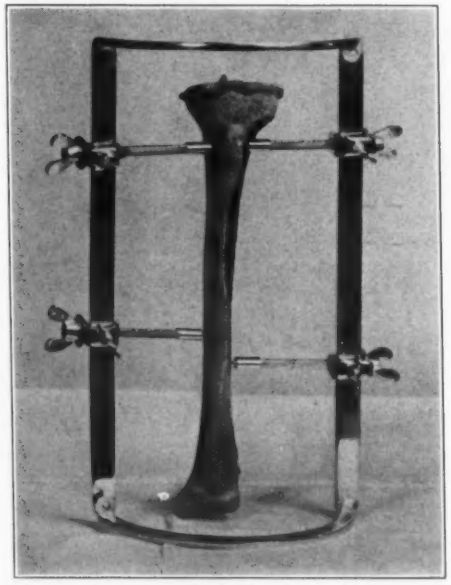

FIG. 6

In the apparatus for lateral correction, the shouldered pins slide on rigid flat side bars, which may be clamped in any position and then advanced by turning the winged nuts at the side. The apparatus should be about eight inches in length.

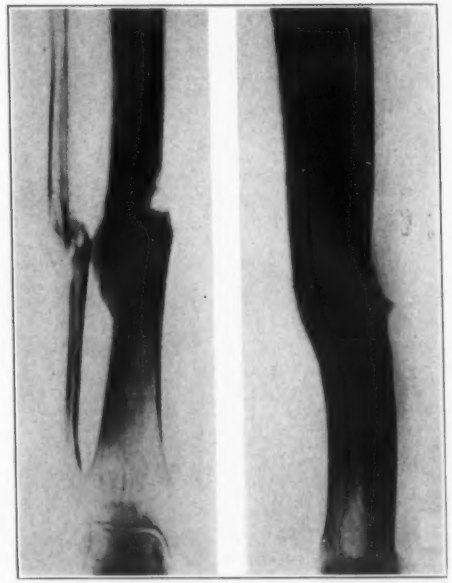

FIG. 7

March 7, 1940. The sequestra have been removed, and there is firm union in good position. Both the shortening and the lateral displacement have been fully corrected.

On October 20, 1939, Steinmann pins and distractors of the Hey Groves type (Figs. 2, 3, and 4), in association with a Braun splint, were used to restore length. Restoration of half an inch (1.25 centimeters) was obtained immediately, and the remaining half inch during the next six days by daily turns of the screws.

Lateral correction was obtained November 1, 1939, under a local anaesthetic, by making small slits in the skin over the tibia and introducing the shouldered ends of the "lateral correctors" (Figs. 5 and 6). The powerful thumbscrews were turned, crushing the callus and easily correcting the lateral displacement. An unpadded plaster was applied.

A cortical sequestrum seen in Figure 5 was removed March 7, 1940, after union had become firm. The result is shown in Figure 7.

The apparatus is also useful for the gradual lengthening of a shortened limb after a corrective osteotomy.

A smaller distractor of the same type may be used for the correction of double fracture of the shafts of the radius and ulna,—the wires being passed through the olecranon and the lower ends of the radius and ulna.

Care must be exercised not to overdistract the bones, but this will not occur if roentgenographic control is used.

THE CONSERVATIVE TREATMENT OF SERRATUS PALSY

BY JOSEF WOLF, M.D., DAVENPORT, IOWA

As with other types of muscle palsy, the isolated paralysis of the serratus anterior can be divided into two stages: the acute paralysis from which recovery is possible, and the late stage in which the paralysis is permanent. The same kind of orthopaedic appliance cannot be used for both stages.

For the former, the purpose is to splint the muscle in a position of complete relaxation, which eliminates the action of its opponents and, thereby, favors recovery.

According to Horwitz and Tocantins, derotation of the scapula is the most important means of restoring the tonicity of the paralyzed serratus. Their brace for serratus palsy consists of a celluloid bucket, which is fastened to a pelvic rest, and receives the flexed elbow, thus eliminating the influence of the weight of the arm upon the shoulder and the antagonistic action of the biceps muscle. Other orthopaedic appliances for acute serratus palsy are Mackenzie's sling about the neck suspending the arm by the wrist, and Faucor's "cloverleaf sling", encircling the unaffected shoulder, the neck, and the wrist of the affected side. Berkheiser and Shapiro use a plaster spica, and Fitchet an aeroplane splint. All devices but that described by Horwitz and Tocantins only counteract the weight-bearing, and the action of the biceps muscle, but do not derotate the scapula.

FIG. 1

Paralysis of the left serratus anterior muscle with winging of the scapula.

An appliance for the late stage of serratus palsy, in which the paralysis is permanent and operative treatment cannot be undertaken, (1) must allow complete use of the arm, (2) must press the winged scapula in its normal position against the wall of the chest, and (3) must prevent its rotation. Thomson and Miles have devised a direct pressure pad over the scapula which, however, does not derotate the scapula.

The brace which is here described fulfills all three requirements. It consists of a metal pad over the protruding scapula, which is molded deep enough to receive the triangular shoulder blade and to hold it with the inner border parallel to the spine, and a second metal pad over the unaffected scapula. Both metal pads are connected by three metal springs. The lowest of these springs extends over the two pads and anteriorly under the armpits on both sides, forming axillary crutches as in standard

body braces, and ending in two spoons placed in the infraclavicular fossae. The function of the spring is to press the pad on the affected side, and, with it, the winged scapula, against the ribs, while the deep molding of this pad affords perfect derotation. To prevent upward sliding, the apparatus is anchored to an abdominal girdle with two posterior straps. They are counteracted by two leather straps which extend over the shoulders from the upper brims of the scapular pads and are fastened to the infraclavicular spoons, thereby holding the brace safely in place. The pads and axillary crutches are padded with felt and covered with chamois skin.

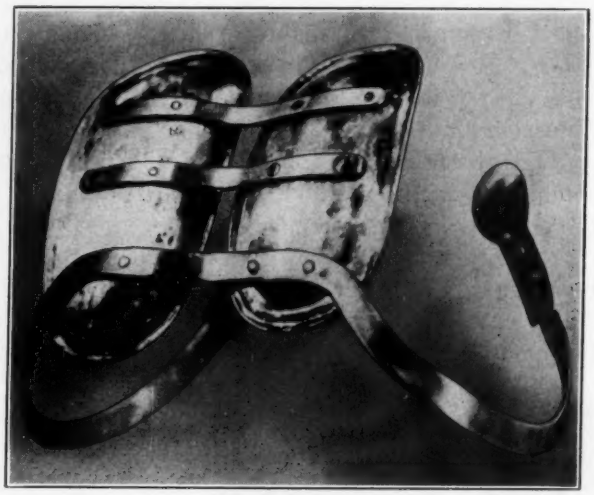

FIG. 2

Metal part of the brace. Note larger and deeper metal pad for the left, winged, shoulder blade. The lowest spring is brought forward as axillary crutches on both sides.

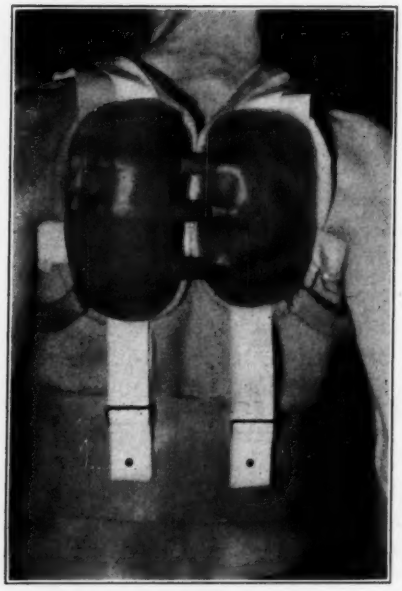

FIG. 3

Back view of the brace which is fastened to an abdominal belt to prevent upward sliding.

FIG. 4

Front view. Note the anterior ends of the axillary crutches as spoons pressing into the infraclavicular fossae.

A machinist, fifty-seven years old, for whom this appliance was devised, incurred the serratus palsy immediately after an operation for ruptured gastric ulcer in September 1940 (Fig. 1). He was first seen seven months later, at which time the chances for recovery of the paralyzed muscle were considered poor. An operation was refused. With the brace just described (Figs. 2, 3, and 4), the patient can raise his arm over the horizontal line, and can forcefully push his hand forward. It enabled him to resume his former work in a power house, which requires the shifting of heavy switches.

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LETTER TO THE EDITOR

To the Editor:

This letter has been suggested by the conclusions of McCarroll and Crego in the abstract of their paper on the Early Treatment of Anterior Poliomyelitis*, presented at the meeting of The American Academy of Orthopaedic Surgeons in January. These are, in effect, that the result is dependent on the amount of destruction that has taken place in anterior horn cells, and that the type of early orthopaedic measures has little or no effect on the course of the disease and alters little, if any, the degree of residual paralysis. The authors support this conclusion by the observation of six different methods, the last of which is no treatment.

I am quite in accord with the main proposition but not with the minor conclusion, for in my opinion the immediate treatment has a most important influence on the course and effects of the disease in its relation to the patient. This treatment should be rest, to relieve pain and to prevent deformity, which may be best assured by plaster splinting if properly applied. The material is always at command and is under the control of the one who applies it. Although the final paralysis is determined by the character of the disease of the cord, its functional effect on the individual is greatly influenced by the quality of the treatment. The purpose of the treatment during the primary stage is to prevent deformity and to assure the attitude most useful in locomotion. In the second period, the most effective means of developing latent power is functional use; and by constructive surgery one may so adjust the mechanics as to assure the best opportunity for its development.

In order to avoid misunderstanding, I shall limit my comments to two types of cases,—namely, paralysis of the calf muscles and paralysis of the anterior thigh group of muscles. When it may appear that the repair of the disease of the cord has been accomplished, the most effective treatment of its secondary effects is locomotion on the protected limb. When the degree of permanent paralysis has been clearly determined, one may consider constructive surgery from the standpoint of promoting ease and security in locomotion. In the first instance, by far the most important consideration is to restore the stability of the foot, since the most disabling form of partial paralysis is loss of resistance to dorsal flexion. For this, astragalectomy with backward displacement of the foot is by far the most effective remedy, and its effect in stimulating the nutrition and growth of the limb is often surprising. Another effective aid is transplantation of the biceps for paralysis of the anterior thigh group. It may be noted, however, that it is of no value unless resistance of the forefoot is restored, which is essential to locking the knee in extension. The transplanted biceps may then restore a practically normal gait, since it enables the patient to swing the leg forward when the foot is lifted. As compared to these fundamental principles, other treatment is of subsidiary importance.

In conclusion, it may be emphasized that the paper referred to considers only the negative effects of physiotherapy on the residual paralysis, while my comments are concerned with the influence on the final functional result of positive, immediate, and consecutive treatment supplemented by surgical intervention.

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* See page 851 of this issue of *The Journal.*

END-RESULT STUDY OF THE TREATMENT OF IDIOPATHIC SCOLIOSIS

REPORT OF THE RESEARCH COMMITTEE OF THE AMERICAN ORTHOPAEDIC ASSOCIATION*

The Research Committee of The American Orthopaedic Association, aided by a grant from the Alfred I. duPont Institute of The Nemours Foundation, has undertaken a study of the methods and end results of treatment of idiopathic scoliosis in an effort to establish the present status of this condition, and to clarify, in so far as possible, what can be expected from the present methods of treatment. Lateral curves, due to congenital anomalies, poliomyelitis, empyema, and any other recognizable disease process, were excluded from the study.

Cases were reviewed from an end-result standpoint in sixteen orthopaedic clinics throughout the country. This included a study of 425 case histories, roentgenograms, and photographs. An end-result physical examination was made (by L. N.) of 127 of the patients. The Committee wish to express their appreciation for the cooperation and valuable assistance given in this survey by the Orthopaedic Departments of the following clinics: Shriners' Hospital for Crippled Children in San Francisco; the Orthopaedic Hospital in Los Angeles; Carrell-Girard Clinic and Texas Scottish Rite Hospital for Crippled Children in Dallas; Crippled Children's Hospital in Oklahoma City; Willis C. Campbell Clinic Hospital in Memphis; University Hospitals in Iowa City; Mayo Clinic, Rochester; University Hospital, Ann Arbor; Hospital for Sick Children, and Toronto General Hospital, Toronto; Hospital for the Ruptured and Crippled, New York Orthopaedic Dispensary and Hospital, and Hospital for Joint Diseases in New York; Shriners' Hospital for Crippled Children in Philadelphia; Johns Hopkins Hospital and Children's Hospital School, and The James Lawrence Kernan Hospital and Industrial School of Maryland for Crippled Children, in Baltimore; Shriners' Hospital for Crippled Children in Springfield; and Children's Hospital, and Massachusetts General Hospital in Boston.

TABLE I
ETIOLOGY

Probable Etiology of Idiopathic Scoliosis	Clinicians Supporting View
Curvature is the result of failure of muscular and skeletal systems to maintain a balance during the rapid growth period, and is associated in some way with an endocrine or metabolic disturbance	4
Curvature is primarily the result of muscle imbalance, the source of the imbalance being unexplained, but possibly being postural fatigue, an unrecognized poliomyelitis, or some similar process	7
Curvature is the result of a growth disturbance at the epiphyseal plate of the vertebrae, possibly related to an osteochondritic process or to epiphyseal trauma with an associated deficiency, either metabolic or dietary	6
Curvature is the result of postural faults, acquired during growth and fatigue of adolescence, prolonged sitting in school, etc., which gradually lead to a fixed deformity	6
Curvature is an exaggeration of physiological deviation occurring during normal gait, being greater toward the right side due to the weight of organs, and passing beyond normal limits in the presence of some body insufficiency	2
Hereditary and environmental factors are felt to be definitely contributory	2

* Read at the Fifty-Fifth Annual Meeting of The American Orthopaedic Association in Toronto, Canada, June 10, 1941.

TABLE II

NATIONALITY

(252 Cases)

	Per Cent.		Per Cent.
Jewish	27	Norwegian	3
"American"	25	Greek	2
Italian	14	Syrian	2
German	7	Japanese, Scotch, Lithuanian, French, Armenian	4
Negro	6		
English	4		
Polish	3		
Irish	3		

An expression of ideas concerning the etiology of the idiopathic type of scoliosis was obtained from the men in the various clinics, and these may be divided into five general groups, as shown in Table I. Research is being carried on by some of these men at the present time, with the hope that some more effective program of prophylaxis and treatment may be worked out.

Data on nationality was available in 252 cases, as shown in Table II. The predominance of cases of the Jewish race may be due to the fact that the large Eastern cities (New York, Baltimore, and Boston) contributed substantial numbers of cases to the series, and there is a high percentage of Jewish population in these cities.

TABLE III

COMPLAINT

		Per Cent.
Cosmetic		92
Curvature	57	
High or prominent shoulder	27	
Prominent hip	8	
Backache		8
Total		100

Girls predominated four to one, there being 82 per cent. females and 18 per cent. males. Incidence of curvature in others of the same family amounted to 7 per cent. (twenty-seven cases of the 386 in which family history was recorded).

The presenting complaint was of cosmetic deformity in 92 per cent. of the cases, and of backache in 8 per cent. (Table III). In the group of thirty-six patients with backache, only 6 per cent. were less than twelve years of age; 22 per cent. were between twelve

TABLE IV

AGE OF ONSET

(404 Cases)

Age (*Years*)	No. of Cases	Age (*Years*)	No. of Cases	Age (*Years*)	No. of Cases
2	1	8	14	14	55
3	1	9	18	15	26
4	2	10	34	16	8
5	8	11	46	17	3
6	9	12	88	18	1
7	11	13	78	19	1

and fourteen years; and 72 per cent. were fourteen years and over. Pain, therefore, is an infrequent early symptom in scoliosis.

Onset of the scoliosis was noted between the age of seven and fifteen years in 92 per cent. of the cases (Fig. 1 and Table IV), the most frequent being twelve years of age. Patients presented themselves for treatment within the first year in 55 per cent. of the cases.

An attempt was made to determine the primary curve (Table V) which, in each instance, was taken to be the chief deforming curve, and the one to which other existing curves appeared to be compensatory. There was generally greater rotation and vertebral wedging in the primary area, and it was incompletely correctable on forward or side bending. Right thoracic or thoracolumbar curves were present in 80 per cent. of the cases, while 20 per cent. were left thoracic or thoracolumbar. There were no right lumbar curves and only two were left lumbar.

The extent of the curve (Table VI) varied from a minimum of four vertebrae to a maximum of twelve vertebrae, and 91 per cent. were between six and nine in extent. The vertebra showing the greatest amount of rotation was taken to be the apex of the curve, and this was found to be the ninth thoracic in 24 per cent. of the cases, with the eighth thoracic the next most frequent, 22 per cent., and the first lumbar the third in

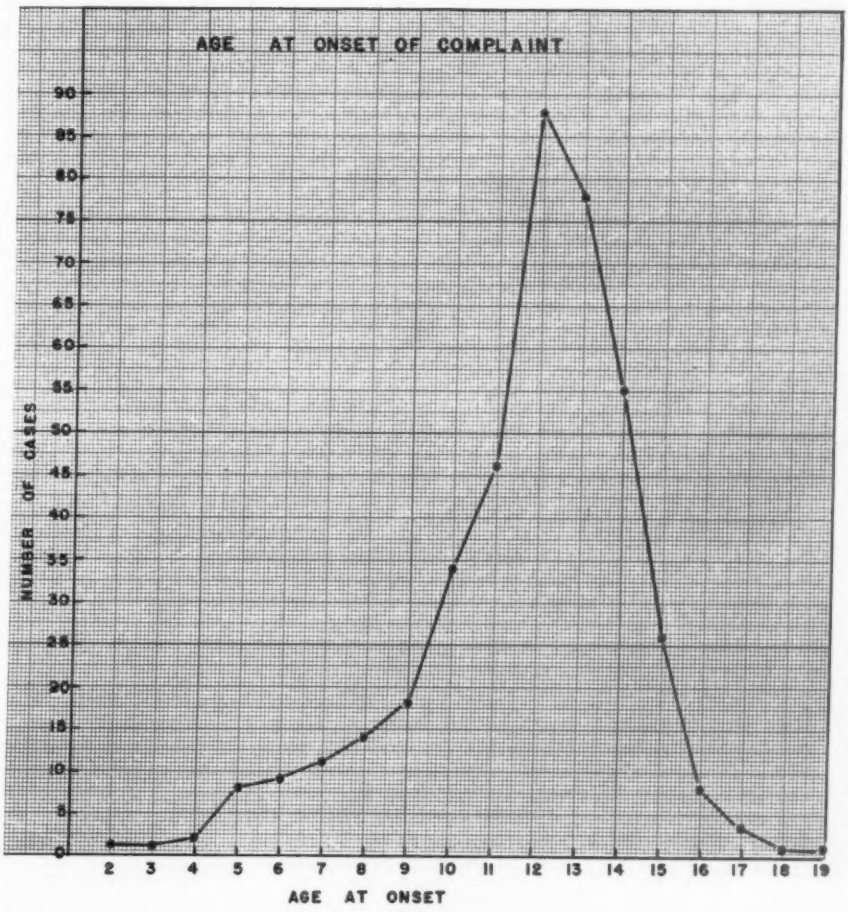

FIG. 1

frequency, 11.5 per cent. (Fig. 2 and Table VII). Mobility of the thoracolumbar junction probably accounts for the increased occurrence at that level.

A measure of the severity of the curve was obtained by determining the end or neutral vertebra on either extreme. These were taken to be the ones showing the least rotation, with the interspace approximately equal on either side. A line was then drawn parallel with the top of the upper-end vertebra and one parallel with the bottom of the lower-end vertebra and a perpendicular erected to each of these lines. The angle of deviation from the normal (180 degrees) was then measured at the intersection of these two perpendicular lines (Fig. 3). These measurements were made on roentgenograms taken with the patient standing and supine when both were available, as an indication of flexibility of the curve. The distribution of the curves is shown in Figure 4. With slight curvatures—0 to 20 degrees—there was very little difference in standing and supine positions. Moderate curves—25 to 40 degrees—showed 5 to 10 degrees difference, while severe curves—45 degrees and over—were fairly rigid and showed but slight increase in standing measurements.

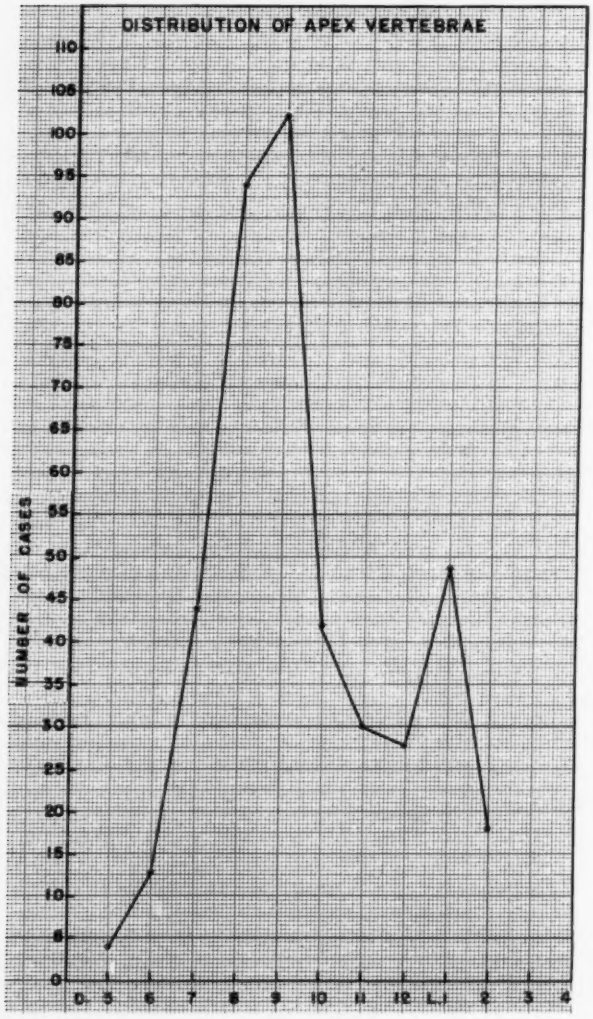

FIG. 2
Distribution of apex vertebra.

Eleven patients in the series measured the same in standing and supine positions, 36 per cent. being patients between eleven and thirteen years and 64 per cent. being patients over fourteen years at start of treatment. This further indicates the tendency for the curve to become fixed in the older group.

A review of the body asymmetry showed the shoulder to be high on the right in 56 per cent., high on the left in 23 per cent., and shoulders level in 21 per cent. Measurements varied from one-quarter to two inches, the average being between a quarter and a half inch (Table VIII). Lateral deviation of the center of the sacrum from a plumb-line dropped from the seventh cervical vertebra was noted. Forty-five per cent. showed no list, 40 per cent. listed to the right, and 15 per cent. to the left. For those with a list the measurements varied from one-fourth to two inches (Table IX), the majority being

TABLE V

PRIMARY CURVE

Location of Curve	No.	Per Cent.	
Right thoracic	230	54.0	79.5
Right thoracolumbar	109	25.5	
Left thoracic	23	5.5	20.0
Left thoracolumbar	61	14.5	
Right lumbar	0	0.0	0.5
Left lumbar	2	0.5	
Total	425	100.0	

one-fourth to one-half inch. The list and high shoulder were generally on the side of the primary convexity, and, along with measurements of standing and sitting height photographs, and roentgenograms, serve to estimate the clinical progress of treatment.

Treatment varied in the different clinics (Table X) according to what the surgeon felt was an acceptable result, considering the amount of treatment necessary to arrive at that goal and the probability of maintaining such a status once it had been attained.

TABLE VI

EXTENT OF CURVE

No. of Vertebrae Involved	No. of Cases	Per Cent.	
4	1	0.25	
5	10	2.5	
6	64	15.0	387 cases, or 91 per cent., were 6 to 9 vertebrae in extent
7	127	30.0	
8	142	33.5	
9	54	12.5	
10	19	4.5	
11	7	1.5	
12	1	0.25	
	425	100.0	

It was generally felt that a mild curve with good compensation and slight body asymmetry was best treated by symmetrical postural exercises under close observation, so as to maintain a certain amount of flexibility and to improve posture. Asymmetrical exercises were carried out in a few clinics to produce mobility and to aid in regaining compensation; and in some instances to favor weaker muscles and reduce the pull of stronger ones, particularly by those who feel that muscle imbalance is a factor in the production of idiopathic scoliosis. Most men agree that postural improvement can be expected from a regimen of exercises, but the curve itself cannot be decreased by this

TABLE VII

APEX OF CURVE

Location	No.	Per Cent.	Location	No.	Per Cent.
Fifth Thoracic	4	1.0	Tenth Thoracic	42	10.0
Sixth Thoracic	13	3.0	Eleventh Thoracic	30	7.0
Seventh Thoracic	44	10.5	Twelfth Thoracic	28	6.5
Eighth Thoracic	94	22.25	First Lumbar	49	11.5
Ninth Thoracic	102	24.0	Second Lumbar	18	4.25
Total				424	100.0

means. Strenuous exercises should be prescribed cautiously, since they may mobilize a rigid curve and allow further collapse.

Some form of support was used during the exercise and observation period, and was felt to be of benefit in many clinics. This generally consisted of a light brace, incorporating a lateral corrective force, such as the turnbuckle brace and the elastic traction brace, or a light plaster or a jacket of cellulose acetate composition.

Of 185 patients originally treated by exercises of all types (Table XI) the curve in 35 per cent. remained unchanged, in 34 per cent. increased moderately (5 degrees to 15 degrees) and in 27 per cent. increased markedly (20 degrees and over). An improvement of 5 degrees was shown in 4 per cent.; this may be within the limits of error of measure-

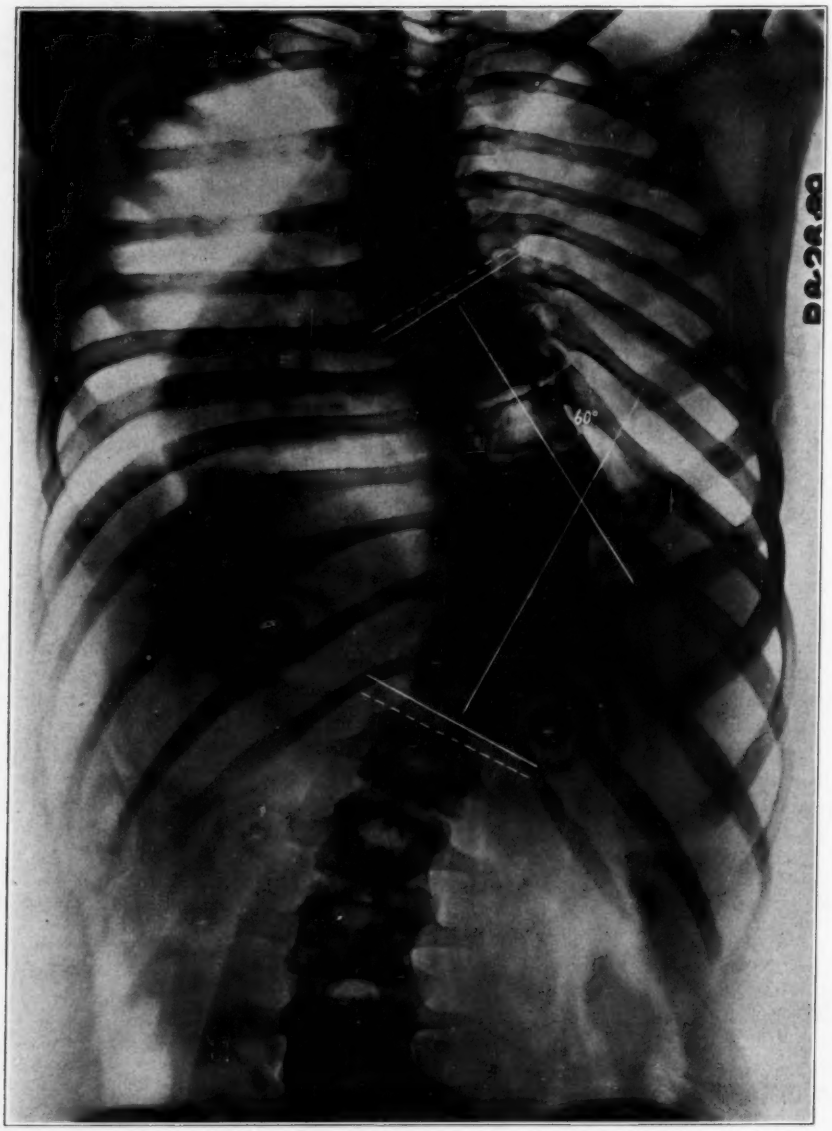

FIG. 3

Illustration of method of measurement of the curvature.

TABLE VIII

SHOULDER LEVEL

(405 Cases)*

Difference in Level (*Inches*)	High Shoulder on Right		High Shoulder on Left	
	No. of Cases	Per Cent.	No. of Cases	Per Cent.
¼	103	25.5	46	11.25
½	107	26.5	35	8.50
¾	8	2.0	1	0.25
1	9	2.25	8	2.0
1½	1	0.25	1	0.25
2	0	0.0	1	0.25
Total	228	56.5	92	22.5

* No difference in level in 85 cases or 21.0 per cent.

TABLE IX

LIST

(395 Cases)

	Per Cent.		Per Cent.
No list	45	Left ¼ inch	5
Right ¼ inch	12	Left ½ inch	6
Right ½ inch	16	Left ¾ inch	1
Right ¾ inch	4	Left 1 inch	2
Right 1 inch	6	Left 1¼ inches	0.5
Right 1½ inches	1	Left 1½ inches	0.5
Right 2 inches	0.5	Left 2 inches	0.5

Total list to right ..... 39.5 per cent.
Total list to left ..... 15.5 per cent.
No list ..... 45.0 per cent.

ment. The curve in one patient apparently improved 10 degrees. It is interesting to note that 53 per cent. of those having symmetrical postural exercises showed an increase of curvature, while 75 per cent. of those having asymmetrical exercises showed increase in curvature, possibly due to the more vigorous type of exercises.

Correction, followed by support, without subsequent fusion is carried out in selected cases in three clinics, while correction and fusion is the method of choice for progressive cases within the growth period according to the majority. Fusion without correction has generally been limited to long-standing cases in patients with symptoms of back strain, or when conditions would not permit the prolonged hospitalization required for correction.

Correction has been accomplished by means of windowed casts for gradual wedging

TABLE X

TYPE OF TREATMENT CARRIED OUT IN VARIOUS CLINICS

	Yes	*No*
Symmetrical postural exercises	16	2
Asymmetrical mobilizing exercises for compensation	7	11
Brace or plaster support during exercise observation period	12	6
Correction followed by support without fusion in progressing cases	3	15
Correction and fusion in progressing or badly deforming cases	16	2
Fusion without correction in progressing or symptomatic cases	2	16

TABLE XI

EXERCISES AND EFFECT ON CURVES (IN PERCENTAGES)

Effect on Curves	Average for All Curves (185 Cases)	Symmetrical Exercises			Asymmetrical Exercises		
		Mild Curves 0–20° (26 Cases)	Moderate Curves 25–40° (55 Cases)	Severe Curves Over 40° (39 Cases)	Mild Curves 0–20° (10 Cases)	Moderate Curves 25–40° (25 Cases)	Severe Curves Over 40° (30 Cases)
Unchanged	35	30	49	42	10	28	21
Increased: (5–15°)	34	54	23	39	50	40	50
(20° and over)	27	16	21	17	30	32	26
Improved (5°)	4	0	7	2	10	0	3
Total	100	100	100	100	100	100	100

with felt pads, by the Cook cast which incorporates lateral traction bands through a window in the plaster, by horizontal suspension in a fishnet hammock during plaster application, and by the Risser turnbuckle jacket (Table XII). The latter was the most popular method of correction.

The Risser jacket was used to correct the curve prior to fusion in 149 patients (Table XIII). In those with mild curvature—0 to 20 degrees—an average of 71 per cent. correction was obtained. With moderate curves—25 to 40 degrees—an average of 72 per cent. correction was obtained (fifty-one cases), and in severe cases—45 degrees and over—53 per cent. correction was the average (eighty-eight cases). The percentage of correction in the end result in these same groups averaged 33 per cent. in the mild group, 25 per cent. in the moderate group, and 24 per cent. in the severe group. Patients corrected by other means are not numerous enough for individual percentages and will therefore be considered as one group. There were thirty-one such cases, and, including all degrees of curvature encountered, an average of 42 per cent. correction immediately postoperative was obtained, and the percentage of correction in the end result amounted to 15.

TABLE XII

METHOD OF GAINING CORRECTION

Apparatus	Number of Clinics Using the Method
Risser turnbuckle jacket	13
Fishnet horizontal suspension jacket	2
Bent jacket, with window and pressure pads	1
Bent jacket, with window for lateral traction bands	1
Head, pelvic, and lateral traction	1

In the entire group of 180 patients corrected and fused, complete correction was gained in ten, or 5.5 per cent. There was complete loss of correction in fifty-three patients, or 30 per cent., and no loss of correction in fifteen, or 8 per cent.

Correction without fusion, carried out in thirty-two patients, resulted in a total loss of correction, after discontinuing support, in 72 per cent. of the cases (Table XIV).

Some clinical improvement of the rotation deformity occurred following correction with the Risser jacket in 48 per cent. of the 126 patients on whom these data were

TABLE XIII

AVERAGE OF PERCENTAGE OF CORRECTION OF EACH CURVE

Type of Curve	Risser Jacket			Other Types		
	No.	Immediately Post-operative (*Per Cent.*)	End Result (*Per Cent.*)	No.	Immediately Post-operative (*Per Cent.*)	End Result (*Per Cent.*)
Mild (up to 20 degrees)	10	71	33	1	85	45
Moderate (25 to 40 degrees)	51	72	25	8	40	15
Severe (45 degrees and over)	88	53	24	22	41	13
Total	149	61	25	31	42	15

TABLE XIV

CORRECTION WITHOUT FUSION

(32 Cases)

72 per cent. lost all of correction gained
10 per cent. maintained 5 degrees of correction
12 per cent. maintained 10 degrees of correction
6 per cent. maintained 15 degrees of correction

100 per cent.

TABLE XV

COMPARISON OF ROTATION BEFORE AND AFTER TREATMENT WITH RISSER JACKET IN 126 CASES WITH KNOWN RESULTS

61 cases, or 48 per cent., showed less rotation
53 cases, or 42 per cent., showed same rotation
12 cases, or 10 per cent., showed more rotation

126 100 per cent.

available. The deformity apparently changed very little in 42 per cent., and was more noticeable in 10 per cent. (Table XV).

The most frequent fusion employed additional bone, generally from the tibia. A classical Hibbs fusion was done in eighty-three patients, and pseudarthrosis resulted in twenty-four instances or 29 per cent.; a Hibbs fusion plus a graft in fifty-two patients resulted in seventeen pseudarthroses or 33 per cent.; the Albee fusion in four instances, with 25 per cent. pseudarthrosis; a McKenzie Forbes type in seventy-four instances, with seventeen pseudarthroses or 23 per cent.; and one strut graft was done, resulting in pseudarthrosis. Incidence of pseudarthrosis for the entire group was 28 per cent. (Table XVI). These percentages represent only a small group for each type of fusion, and are subject to the varying technique and subsequent care of many clinics.

There were 180 patients who were corrected and fused, with resulting pseudarthrosis in fifty-four instances. Average loss of correction in the pseudarthrosis group was 21.2 degrees, and in the non-pseudarthrosis group 15.1 degrees. Apparently, while pseudarthrosis is a contributory factor in the loss of correction, it is not the chief cause. Early detection and repair of the pseudarthrosis, however, will save some loss of correction.

TABLE XVI

TYPE OF FUSION AND INCIDENCE OF PSEUDARTHROSIS

Type of Fusion	Cases	Pseudarthrosis	
		No.	Per Cent.
Hibbs fusion	83	24	29
Hibbs fusion and bone grafts	52	17	33
Albee	4	1	25
McKenzie Forbes	74	17	23
Strut graft	1	1	100
Total	214	60	28

Correlation between loss of correction and period of recumbency is shown in Table XVII. The usual period of recumbency appears to be from three to four months. Recumbency for six months or more did not seem materially to reduce the loss of correction in this series. Immobilization during recumbency was in plaster jackets in 204 of the 214 patients who were fused, and this is felt to be the best method of maintaining correction. Support should be continued after the patient becomes ambulatory for a total period of seven to nine months to allow the fusion mass to become thoroughly solid, since it must resist not only the strain of superincumbent weight, but also the tendency for contractures to pull the spine back to the deformed position. Ordinary back braces apparently do not maintain correction during this period unless they incorporate some lateral corrective force as well as support.

The extent of the fusion area varied from four to seventeen vertebrae as shown in Table XVIII. Selection of the area of fusion should be carefully made and should include all of the primary curve. Results in the group with correction and fusion show that those in whom fusion was less than the primary curve lost more than those in whom all the primary curve was fused. The greatest amount of correction was maintained in those patients in whom the area of fusion included more than the primary curve (Table XIX).

Correctability of the secondary curve should be determined before correction and

TABLE XVII

LOSS OF CORRECTION

Comparing Amount of Loss of Correction with Period of Recumbency

Recumbent (*Months*)	Loss 0 to 10 Degrees (*Per Cent.*)	Loss 15 to 25 Degrees (*Per Cent.*)	Loss 30 Degrees and Over (*Per Cent.*)	Total (*Per Cent.*)
2	28	50	22	100
3	42	41	17	100
4	35	41	24	100
5	67	11	22	100
6 and over	48	39	13	100

The percentages of all patients with fusion for periods of recumbency are: up to two months, 15.5; three months, 47; four months, 22.5; five months, 5.5; six months, 4; and seven months, 5.5.

TABLE XVIII

EXTENT OF FUSION

Vertebrae Involved	No. of Cases	Per Cent.	Vertebrae Involved	No. of Cases	Per Cent.
4	1	0.5	11	33	15.5
5	6	2.75	12	10	4.75
6	13	6.0	13	8	3.75
7	20	9.25	14	9	4.25
8	33	15.5	15	5	2.25
9	36	16.75	16	1	0.5
10	38	17.75	17	1	0.5
Total				214	100.0

TABLE XIX

EXTENT OF FUSION AND LOSS OF CORRECTION

Fusion less than the primary curve (33 cases)
75 per cent. lost 0 to 35 degrees
25 per cent. lost 40 degrees or over

Fusion same as primary curve (18 cases)
94 per cent. lost 0 to 35 degrees
6 per cent. lost 40 degrees or over

Fusion greater than primary curve (128 cases)
95 per cent. lost 0 to 35 degrees
5 per cent. lost 40 degrees or over

fusion of the primary curve, to insure the patient's ability to return to the erect position after fusion. Complications encountered in corrected and fused patients, other than pseudarthrosis, were infection involving deep structures, 3 per cent.; deep pressure sores, 3 per cent.; and transient brachial palsy due to stretching during correction, 4.2 per cent.

The period of follow-up varied from one to ten years. Twenty-four per cent. were followed for between one and two years, 63 per cent., from three to five years, and 13 per cent., from five to ten years. An attempt was made to limit end-result studies to patients who were sixteen years of age or over, since it is felt that growth has practically ceased in both male and female patients at that age, and therefore the curvature will remain more or less constant. However, some patients over fifteen, but less than sixteen years, were included where a long follow-up and other criteria indicated that the scoliosis probably was stationary. Fifty-seven per cent. were between sixteen and eighteen years of age, while 27 per cent. were older (nineteen to forty years), and 16 per cent. were younger (over fifteen but not yet sixteen years).

Measurements on the roentgenograms before treatment and at the end result are indicated on the graph (Fig. 4). The number of patients with moderate curvatures shows a fair amount of leveling of the graph peak, and this group represents most of the patients who were corrected and fused. The more severe curves have shown very little response to treatment.

Examination for list of the trunk at end result showed that 40.5 per cent. were improved, 10.5 per cent. were worse, 12 per cent. unchanged, and 37 per cent. had no list.

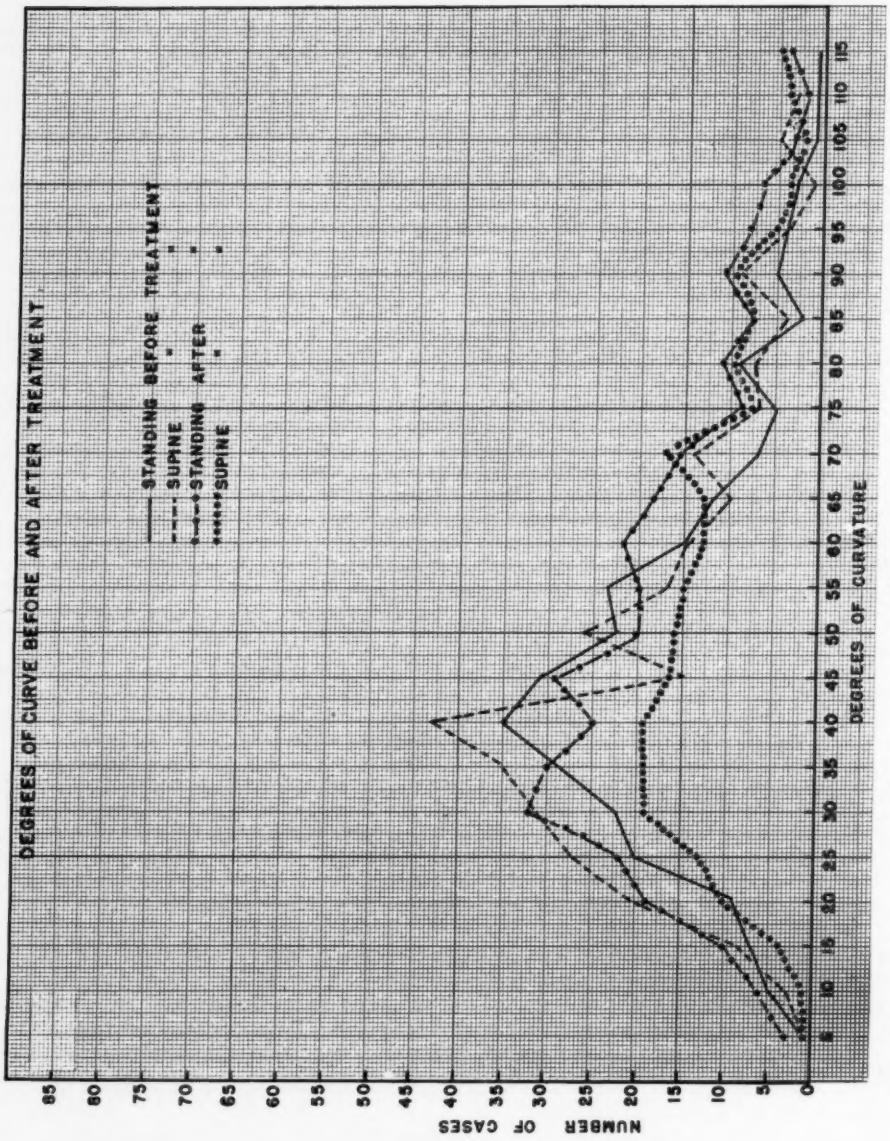

FIG. 4
Curvature measurements before treatment and at end result.

TABLE XX

AGE AT START OF TREATMENT AND END RESULTS (IN PERCENTAGES)

Age (*Years*)	Entire Series						Risser Series					
	No.	Excellent	Good	Fair	Poor	Total	No.	Excellent	Good	Fair	Poor	Total
Two to ten	26	0	19	27	54	100	9	0	0	55	45	100
Eleven	22	4.5	22.5	32	41	100	17	6	40	40	14	100
Twelve	54	4	23	30	43	100	16	6	44	33	17	100
Thirteen	98	2	22.5	52	23.5	100	40	6	37	35	22	100
Fourteen	95	7	35	43	15	100	30	10	30	40	20	100
Fifteen	55	0	36.5	51	12.5	100	12	0	50	33	17	100
Sixteen	34	0	30	47	23	100	9	0	20	50	30	100
Seventeen and over	41	0	24.5	61	14.5	100	16	0	25	50	25	100
Total average	425	3	28	45	24	100	149	5	32	42	21	100

TABLE XXI

TREATMENT AND CLINICAL RESULTS

Clinical Appearance of Back	Risser Jacket and Fusion (132 Cases) (*Per Cent.*)	Risser Jacket without Fusion (16 Cases) (*Per Cent.*)	Other Types of Correction and Fusion (25 Cases) (*Per Cent.*)	Other Types of Correction without Fusion (25 Cases) (*Per Cent.*)	Traction and Fusion (10 Cases) (*Per Cent.*)	Observation Only (18 Cases) (*Per Cent.*)	Exercises (152 Cases) (*Per Cent.*)
Markedly improved	24	0	12	0	0	0	0
Moderately improved	43	0	28	0	40	33	5
Unchanged	22	50	32	48	40	55	59
Slightly worse	9	37	20	32	10	12	20
Much worse	2	13	8	20	10	0	16
Total	100	100	100	100	100	100	100

NOTE: Some cases are listed in more than one group owing to change of treatment.

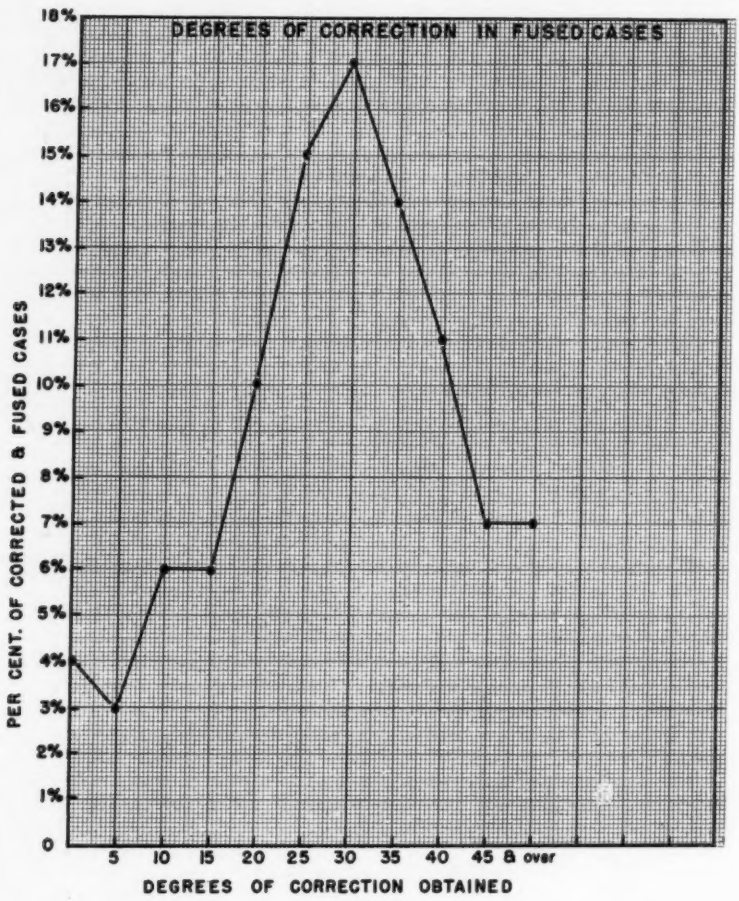

FIG. 5

Improvement of the shoulder level occurred in 50 per cent. of the patients, remained the same in 25 per cent., was worse in 12 per cent., the shoulders were level in 13 per cent. Hip prominence was unchanged in 67.5 per cent., improved in 22 per cent., worse in 8 per cent., and equal in 2.5 per cent.

According to statements by the patients in 252 instances, 72 per cent. felt they were improved, 21 per cent. were unchanged, and 7 per cent. were worse. Relatively few more patients complained of backache at end result than on admission, there being 14.5 per cent. in the former group and 8 per cent. in the latter. Eighty-five per cent. had no complaint of pain. Activities were normal in 85 per cent., slightly limited in 14.5 per cent., and considerably limited in 0.5 per cent. Therefore, in scoliosis treatment the chief concern is for the cosmetic result. The most persistent complaint, even after correction and fusion, is that of the posterior rib prominence, which seems to be more or less permanent.

It is a difficult matter to give an end-result rating to a condition such as this, since the scoliosis itself is rarely cured, and opinions as to what can be and should be achieved at end result are so varied. However, an attempt has been made to form a composite picture considering the physician's aim in treatment, the inconvenience and time necessary to arrive at that goal, and finally whether the condition had been improved, remained stationary, or had progressed. Since 92 per cent. of the complaints were of cosmetic deformity, this must also carry the most weight in end-result rating. Bearing these

points in mind, excellent rating was reserved for those in whom residual deformity was slight and roentgenograms revealed the curve to be of minor degree. Good rating included those patients who had a moderate curvature, but were well balanced and concealed the deformity satisfactorily. Results were rated fair when the curvature was moderately severe and the patient displayed obvious cosmetic defects, while a poor rating was given for those with severe curvature and marked body asymmetry.

Of 425 cases reviewed, twelve, or 3 per cent., were rated excellent; 119, or 28 per cent., good; 191, or 45 per cent., fair; and 103, or 24 per cent., poor. Results in patients with scoliosis appearing before the age of ten years were rather poor, even though they came for treatment early (Table XX). Also, the results in patients in the upper-age group at the start of treatment were not as good as those in the group of twelve-to-fifteen-years. If the clinical appearance of the back at end result is compared with what it was when the patient was first seen (Table XXI), it will be noted that the best cosmetic results were obtained in the group treated by correction in the Risser jacket and spine fusion.

SUMMARY

Four hundred and twenty-five cases of idiopathic scoliosis have been reviewed from an end-result standpoint. Cosmetic deformity is the chief complaint, the patients generally having no other symptoms. It is a disease appearing most frequently at the time of puberty, and predominating in girls about four to one. Curvature is to the right in 80 per cent. of the patients, most commonly in the mid-thoracic region.

All types of treatment were encountered in the series including observation only, symmetrical and asymmetrical exercises, supports, correction, and fusion, and combinations of all types. Fifty per cent. (214) of the patients reviewed had fusions done either immediately or after conservative treatment had been abandoned in favor of surgery. Correction was by means of the turnbuckle jacket in 80 per cent. of those corrected and fused. The average percentage of correction obtained was 65 and the average percentage of correction at end result was 27. Complete correction was gained in only 5.5 per cent. of the corrected cases, all of the correction was maintained in 8 per cent., and there was complete loss of correction in 29 per cent.

Additional bone grafts were used in 60 per cent. of the patients operated upon, and the incidence of pseudarthrosis for the entire operative group amounted to 28 per cent. Recumbency following fusion for three months was carried out with 47 per cent. of the patients.

The results in 69 per cent. of the cases at end result were rated fair or poor, and 31 per cent. good or excellent.

CONCLUSIONS

1. Practically none of the patients with scoliosis are cured, if correction of lateral deviation is a criterion.

2. In approximately 60 per cent. of those treated by exercises the deformity increased and in 40 per cent. it remained unchanged.

3. Correction without fusion resulted in complete loss of correction after support was discontinued, in the majority of instances.

4. Correction by the turnbuckle jacket and subsequent fusion has yielded better results in this series than have other types of treatment.

A. R. Shands, Jr., M.D., *Chairman*
Joseph S. Barr, M.D.
Paul C. Colonna, M.D.
Lawrence Noall, M.D., *Research Fellow of The Nemours Foundation*

News Notes

The Annual Meeting of **The American Academy of Orthopaedic Surgeons** will be held January 11 to January 15, 1942, in Washington, D. C. Headquarters will be at the Mayflower Hotel. Dr. J. E. M. Thomson, of Lincoln, Nebraska, is Chairman of the Program Committee. A group of refresher courses is being planned in conjunction with the regular program.

Dr. Clarence H. Snyder announces the association with him of Dr. Harvey M. Andre in the practice of orthopaedic surgery and the treatment of fractures. Their office is located at 201–202 Medical Arts Building, Grand Rapids, Michigan.

Dr. Roger Anderson has announced that Dr. Ernest Burgess is now associated with him in the practice of orthopaedic surgery, at 1307–1319 Medical Building, Seattle, Washington.

The Annual Meeting of **The Orthopaedic Guild** will be held in Detroit, October 24 and 25. Dr. C. L. Mitchell, of Henry Ford Hospital, will be Chairman of the meeting.

The Annual Clinical Congress of the **American College of Surgeons** will be held in Boston, November 3 to 7, 1941.

Under the auspices of the American Association of Industrial Physicians and Surgeons, the **American Conference on Industrial Health** will hold its Second Annual Meeting on November 5 and 6, 1941, at Chicago Towers, Chicago.

Duke University School of Medicine and **Duke Hospital** announce a Symposium on "Problems of Civil and Military Emergencies" to be held on October 16, 17, and 18, in the Page Auditorium, West Duke Campus, Durham, North Carolina. The program includes an outstanding group of speakers. Dr. Lenox D. Baker is Chairman of the Symposium Committee.

The Association of Military Surgeons of the United States will meet at the Brown Hotel, Louisville, Kentucky, October 29 to November 1. All members of the medical profession are invited, and it is hoped especially that many members of the Medical Defense Committees will attend. Present policies and activities in the medical departments of the United States Army and Navy will be the principal topics of discussion. The session will conclude with a mass review of Military Medicine and an inspection of Fort Knox.

THE BRITISH ORTHOPAEDIC ASSOCIATION

The Summer Meeting of The British Orthopaedic Association, under the presidency of Prof. T. P. McMurray, was held at the Robert Jones and Agnes Hunt Orthopaedic Hospital, Oswestry, on August 9, 1941. A large number of members attended, and among the guests were representatives of the American Hospital in Britain.

The scientific program consisted of a clinical demonstration and the presentation of several short papers, of which the following is a résumé:

SLIPPED UPPER FEMORAL EPIPHYSIS. By N. W. Nisbet, F.R.C.S., Oswestry.

In a twelve-year period at the Robert Jones and Agnes Hunt Orthopaedic Hospital, twenty-six patients suffering from epiphysiolysis had been treated by traction. There had been a long period of symptoms of a fleeting nature before medical advice was sought, and roentgenograms *in two planes* always revealed a greater or lesser amount of displacement. The speaker found that traction did not change the position in those cases with mild displacement, but sometimes produced considerable, although not complete, correction in those in which displacement was severe. Prolonged heavy traction appeared to have an adverse effect on the hip and knee joints and in this series seemed to be partly responsible for the development of arthritis in the hip joint. Mr. Nisbet concluded that:

1. When displacement is slight, no effort should be made to correct it; the hip should be protected, and weight-bearing should be avoided until the epiphysis has fused. In this way normal function can be achieved. Perhaps the insertion of a Smith-Petersen nail would hasten recovery, provided it did not damage the blood supply of the capital epiphysis.

2. When displacement is pronounced and not of long duration, sufficient correction can be achieved by cautiously applied traction, ensuring a satisfactory result.

3. If severe displacement cannot be corrected by traction or is of long duration, the best results follow a subtrochanteric osteotomy to correct deformity, and this treatment is much to be preferred to persistent and vigorous traction.

PSEUDOFRACTURE OF THE TIBIA. By N. L. Capener, F.R.C.S., Exeter.

A child, aged seven, had complained for a month or so of discomfort about the ankle. Roentgenograms at that time were negative. Three weeks later a further roentgenogram showed a crack in the lower diaphysis of the tibia with subperiosteal new-bone formation,—appearances strongly suggestive of a "fatigue" fracture. Recovery was uneventful.

OPERATIVE TREATMENT OF INTRA-ARTICULAR FRACTURE OF THE UPPER END OF THE TIBIA. By N. L. Capener, F.R.C.S., Exeter.

Mr. Capener maintained that, because of the soft texture of the cancellous bone in this region, bone pegs and screws are mechanically inefficient. He showed roentgenograms of three patients treated by wire, applied circumferentially around the upper end of the tibia through two incisions, while longitudinal skeletal traction was applied. Early active movements were initiated, and the functional and anatomical results were most gratifying.

ARTHROGRAPHY IN CONGENITAL DISLOCATION OF THE HIP. By Ronald Furlong, F.R.C.S., London.

Roentgenograms of a series of congenitally dislocated hips, in which a contrast medium (perabrodil in pure solution) had been injected within the capsule before and after reduction of the dislocation, were shown. Among many interesting and stimulating observations Mr. Furlong indicated the valuable information that could be gained about the possibilities of a successful manipulative reduction, the accuracy of reduction, and the development of an adequate acetabular roof.

TREATMENT OF FRACTURES OF THE OLECRANON BY EXCISION OF THE DETACHED FRAGMENT. By D. Wainwright, F.R.C.S., Stoke-on-Trent.

A very careful analysis (illustrated by roentgenograms and a moving-picture film) of forty patients treated for fracture of the olecranon was presented. Twenty patients treated by excision of the detached fragment and efficient repair of the extensor apparatus were compared with twenty treated by other methods (chiefly by suture). Excision resulted in a powerful, fully mobile and stable elbow, capable of withstanding the heaviest strain in a shorter time than could be achieved by other methods. Mr. Wainwright considered excision to be the treatment of choice in all patients approaching middle age, whatever the size of the proximal fragment, provided the coronoid process and the head of the radius were intact.

Current Literature

THE INTERVERTEBRAL DISC WITH SPECIAL REFERENCE TO RUPTURE OF THE ANNULUS FIBROSUS WITH HERNIATION OF THE NUCLEUS PULPOSUS. F. Keith Bradford, M.D., and R. Glen Spurling, M.D. Springfield, Illinois, and Baltimore, Maryland, Charles C. Thomas, 1941. $4.00.

In this little book the authors have, on the whole, concisely and excellently portrayed the present status of rupture of the intervertebral disc or, as termed in their book, "rupture of the annulus fibrosus with herniation of the nucleus pulposus".

The embryology, anatomy and physiology, and pathology of the intervertebral disc are first described and illustrated. The authors emphasize the fact that, because of the constant stress and strain brought to bear on the intervertebral discs, any incipient pathology becomes exaggerated without the occurrence of a single severe traumatic episode.

Next, the clinical and roentgenographic investigation of patients with low-back and sciatic pain, and the clinical findings in lumbar herniations of the nucleus pulposus are discussed. The authors state that back pain usually follows injury much more directly than does sciatic pain, and the latter may be mild or absent for several days or weeks following injury. In the large group of patients giving no history of injury, many have occupations which produce constant wear and tear on the lumbosacral spine. The authors feel that this must be considered as important an etiological factor as frank trauma. The Lasègue test is discussed, and a more refined test, called "the sciatic-nerve-stretching test", is suggested. The authors believe that lumbar puncture should be performed on every patient in whom the clinical diagnosis of herniated nucleus pulposus is made. They advise removal of the spinal fluid in three portions of three cubic centimeters each. They feel that roentgenographic examination is more important in excluding other lesions than in making directly the diagnosis of ruptured disc. Lipiodol is considered to be a relatively benign substance, administered in the spinal subarachnoid space, and should be used when the localization of a lesion is in doubt. While there is probably no denying histopathological changes in the leptomeninges at least temporarily after using lipiodol, there is probably no permanent damage to the spinal cord and nerve, in the authors' opinion. The authors have nothing to say about the recent practice of removing lipiodol by lumbar puncture in all cases, whether or not operation is contemplated. This practice probably represents an important advance in the handling of these cases. Also, while the use of air for contrast myelography is mentioned, it is not described in detail, and this is regrettable. Rupture of the intervertebral disc is now considered to be the most common single cause of severe persistent or intermittent sciatic pain. The distribution of pain is said not to be of much help in localizing the lesion. Abnormal sensation—that is, paraesthesia in the form of burning, tingling, etc.—is held to be important.

In the section on treatment and results, the authors emphasize the fact that disability resulting from low-back pain, due to disease of the intervertebral disc, without root pain, is almost always an orthopaedic problem. If the pain is intractable to orthopaedic procedures, however, contrast myelography should be considered. The acute case of low-back pain with sciatic disability should have the benefit of conservative procedures also, before surgical measures are considered. The surgical technique is very thoroughly discussed and should be of great value to those who are occupied with the treatment of this problem. In the postoperative treatment, the authors advise recumbency for from two to three weeks. If the annulus fibrosus has been extensively lacerated, the patient is fitted with a low-back brace before discharge.

The authors next discuss the history and findings in injury to the nucleus pulposus

and allied conditions, such as sacro-iliac and lumbosacral injury, narrowing of the intervertebral foramina, the facet syndrome, spondylolisthesis, contracture of the fascia lata, hypertrophy of the ligamentum flavum, etc.

In their chapter on cervical herniations of the nucleus pulposus, the authors admit that in their advanced cases at least the recoveries are very poor, although exploration should always be made. Thoracic herniations are the least likely to occur because the discs are thinner, the volume of the nucleus is less, and movements are much more limited than in the cervical or lumbar spine.

Thirteen cases are reported. On the whole, these cases do not represent the average but rather the unusual type. Lipiodol was not used in all of them, and the roentgenograms are not representative of the ordinary case of ruptured disc. It might have been preferable to give typical cases with typical roentgenograms, although the unusual ones admittedly are of real interest since, as time goes on, one is confronted with an increasing number of atypical cases which must be diagnosed and properly treated. A very complete bibliography is appended.

The book is an excellent one and gives the reader a fundamental understanding of the subject.

ÉTUDES SUR LES AMPUTATIONS ET DÉSARTICULATIONS DES MEMBRES (Studies on the Amputations and Disarticulations of the Extremities). P. Huard. Paris, Masson & C^ie^, and Hanoi, Indo-China (G. Taupin & C^ie^), 1940.

It is unfortunate, as the author points out, that the subject of amputations, which had come to assume a relatively minor place in surgery, has been, by the exigencies of recent war, brought to a position of major importance. In recent years relatively few volumes have been devoted exclusively to this subject, and the present work is an attempt to fill this gap.

The book is divided into three large divisions, the first of which is concerned with generalizations on the physiopathology of amputation stumps, and on general indications for amputation, with specific consideration of amputation for special problems. In general, the author is of the Duval school, and inclines to the principle of the elliptical incision, with the longer portion of the ellipse placed over the flexor surface of the extremity to be amputated.

The second portion of the work is dedicated to a consideration of the various amputations and disarticulations of the superior extremities. The third portion is devoted to a consideration of the problem presented by amputations and disarticulations of the lower extremities. All of the standard operative interventions are discussed and each technique is described in considerable detail. However, this is not just a compilation of operative techniques. On the contrary, it is an exhaustive and intelligent survey of the problem, not only from the technical and surgical point of view, but more particularly from the patient's point of view. The question of reeducation and psychic readaptation of the patient to the altered conditions under which he must continue his activities is discussed in a most understanding manner.

Particular attention is paid to the type of prosthesis which must be applied to the patient after operation. Emphasis is laid upon the opinion that the amputation must be adapted to the mechanical efficiency of the prosthesis, rather than the prosthesis adapted to the operation. The author always bears in mind and stresses the fact that this is not an academic problem, but rather is one of intensely practical importance. The sites of election for amputation, in regard to both the level of amputation and the application of the prosthesis, are emphasized.

A short chapter on the technique of lumbar ganglionectomy is appended. Numerous details of anatomical, surgical, and functional significance, culled from the wide experience of the author, are constantly discussed at appropriate length.

The work is adequately illustrated, with somewhat less than 300 plates, half-tones, and line drawings, which show the effect of war-time economy. There is an extensive

index of authors, and an elaborate bibliography, which amply indicates not only the wide learning of the author, but also the exhaustive nature of the work.

INFANTILE PARALYSIS—ANTERIOR POLIOMYELITIS. Philip Lewin, M.D., F.A.C.S. Philadelphia, W. B. Saunders Co., 1941. $6.00.

This new book attempts to give the whole story of infantile paralysis, and succeeds very well. The chapters on Etiology, Epidemiology, and Predisposing Factors are ably presented in a simple concise style by Dr. Howard J. Shaugnessy. An excellent chapter on Pathogenesis and Pathology is written by Dr. Sidney O. Levinson. The remainder of the book appears under the author's name.

No phase of the disease or of its treatment is omitted. As may be expected in such a text, many controversial subjects are presented. As an example, the use of human convalescent serum in the early treatment of the disease is emphasized, whereas in the opinion of many other authorities, convalescent serum is no longer considered to have any protective or curative effect. The various methods of applying physical therapy, including underwater treatment, are ably presented. However, the real value of physical therapy during the convalescent stage of infantile paralysis is now being questioned, and insufficient emphasis is given this most important discussion.

Many, if not most, of the corrective operative procedures utilized in the care of anterior poliomyelitis are presented. The subject is well handled for this type of book—written apparently for *the student, the practitioner,* and *the specialist*—although the indications and choice of procedures are not always clear.

In the Appendix of the book is included much valuable information relative to the Public Health, Nursing, and Educational problems.

The book may be highly recommended as a reference text for those interested in the treatment of infantile paralysis. The subject matter is presented in encyclopaedic form, leaving the actual choice of method or procedure to the judgment of the reader.

BODY MECHANICS IN HEALTH AND DISEASE. Joel E. Goldthwait, M.D.; Lloyd T. Brown, M.D.; Loring T. Swaim, M.D.; and John G. Kuhns, M.D. With a Chapter on the Heart and Circulation as Related to Body Mechanics by William J. Kerr, M.D. Ed. 3. Philadelphia, J. B. Lippincott Co., 1941. $5.00.

In the first edition, the authors called attention to the fact that the chronically ill were given but scant attention, and that most of those acutely ill, presenting more interesting and solvable problems, were given the most attention. Opportunity was taken in this third edition to change the title to "Body Mechanics in Health and Disease". The authors say: "The early recognition and proper treatment of conditions which inevitably lead to disease are the most important functions of modern medicine", and also, "most of the chronic diseases are associated with the wrong use of the body which must have begun in childhood or early adult life". They have added, therefore, a chapter on "Developmental Deformities". An interesting chapter has been contributed also by William J. Kerr of California concerning the heart and circulation as related to body mechanics.

This book is filled with generalizations and what might be called loose statements, which would not withstand close scrutiny. For example, it is stated that chronic valvular diseases of the heart are very common and one of the commonest causes of death. Today it is well known that chronic hypertensive diseases of the heart and angina pectoris are far more common causes of death than valvular disease. The statement is also made that electrocardiography, in determining the amount of damage to the cardiac muscle, has no direct value on prognosis. This statement can very rightfully be challenged. For example, in complete heart block and in cases where there has been an infarct, the electrocardiogram does have a very direct diagnostic value and, therefore, prognostic value, because, while the exact length of life cannot be predicted, it is well known that these patients do not live very long. However, the book presents a point

of view that is valuable, and it should be interesting to any practitioner. The rank and file of the profession treat their patients as individuals, and they often do not classify the individual as to type based upon anatomical and physiological background. Therefore, the discussion of the three different types of individuals which the authors call the normal—that is, the intermediate, the slender, and the stocky—is interesting. They, themselves, acknowledge the dangers of too close an adherence to this generalization.

They make the statements that the slender and stocky types can be recognized in all age periods, but in a pure form are almost as rare as the intermediate type, although the proportion of individuals of slender type is increasing, and that mixtures and gradations of types are common. These deductions were apparently based on the statistics of Dear in a study of a large number of officers in the United States Army.

The chapter on "Angina Pectoris and Postural Emphysema Related to Obesity" by Kerr presents an interesting point of view, and one which very evidently fits in with the theories of the orthopaedic surgeons writing this book. However, it is to be noted that other observers and workers in cardiology have not been so enthusiastic about the treatment with the Kerr-Lagin belt as are the authors.

In the various chapters are included case reports which are interesting. However, in the chapters on diseases of the nervous system, the authors state they do not wish to assert "the correction of body mechanics will cure all chronic nervous diseases", which would intimate that they would feel they can cure some. The case reports on multiple sclerosis are very interesting, and some interesting recoveries were made. It probably was not the intention of the authors to claim that the correction of poor posture, et cetera, caused recovery, but they do say that "while the exact cause of this condition is not perfectly understood, in many cases when the faulty body mechanics with the associated physiologic disturbances is corrected, health is restored". This is a broad statement, and there is not much to back it up. No series of cases is presented and the data presented are sketchy.

The chapter on chronic arthritis is very good, as would be expected.

The chapter on the foot is too short to be of much value, and here, again, generalization and broad statements weaken the presentation.

The final chapter on "Public Health Aspects of Body Mechanics" savors of the crusader. Nevertheless, there is much that is sound in it, and all orthopaedic surgeons would agree that much of the teaching suggested should be carried out in our schools, colleges, et cetera.

EL PIE TALO POLIOMIELÍTICO Y SU TRATAMIENTO (ESTUDIO DE 170 CASOS) [The Club-Foot of Poliomyelitis and Its Treatment (A Study of 170 Cases)]. Dr. Vicente Sanchis Olmos. Madrid, Espasa-Calipe, S. A., 1940. 10 pesetas.

This monograph was written and ready for publication in 1936, but the Spanish War prevented its publication until 1940. It deals with the treatment of the paralytic club-foot. The first 114 of the 142 pages consist of a general discussion of the subject, which is well organized and well presented. The last twenty-eight pages contain an outline of the clinical histories of the 170 cases. The clinical histories are presented in very short abstract form, and are outlined in charts which show the paralyzed muscles, type of deformity, treatment, and end result. The author states that these cases are presented so that any one interested may review the material, himself.

The material in the monograph is very well organized, and the first and longest section, which deals with the discussion of the subject in general, is divided into chapters. The first chapter deals with the normal architecture and physiology of the foot, and goes into the anatomy in some detail. The second chapter deals with the abnormal anatomy and physiology, and here the mechanism of change following poliomyelitis is brought out. Diagrams are presented, together with roentgenograms and photographs of patients. The method in which the deformities develop is gone into in some detail. The cases in the author's series are tabulated in a chart showing which type of deformity is the

most common. The third chapter deals with what the author calls generalities. He states that considerable time should be allowed to elapse between the occurrence of the paralysis and the surgical treatment. Another factor which enters into the treatment is the age of the patient, and no patient should be treated under the age of six years. The fourth chapter deals with what the author calls orthopaedic treatment of paralytic club-foot, and it is somewhat surprising to realize that the word orthopaedic in the sense in which the author is employing it means conservative or non-operative treatment. The last chapter deals with the surgical treatment of these feet, and is divided into categories according to the type of treatment used. Tendon transplants are employed rather commonly in his series of cases. An operation which is not often used in this country, tenodesis, is referred to and employed frequently. Bone-block operations are used very often, and the types employed are described. A frequent one of these is the anterior block of the talus, in which a piece of bone is placed in a wedge in the anterior aspect of this bone. This operation is rather commonly combined with a subastragalar arthrodesis, and the author feels that the results are quite good. He mentions the other types of arthrodesis in the foot. The triple arthrodesis, which is used so much in the United States, is used only seven times in his series of cases, while simple subastragalar arthrodesis was used twenty-one times, and numerous other types of arthrodesing operations were used rather frequently. The results of this type of surgery are analyzed by the author.

The monograph as a whole represents a very careful study and analysis of the case studies. An American reader would find very much of interest, and quite a good deal with which he would probably not agree, but at the same time he might learn a good deal about unfamiliar operative procedures. The book is well illustrated with photographs, roentgenograms, and drawings.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX. H. Letheby Tidy, M.A., M.D. (Oxon.), F.R.C.P., and A. Rendle Short, M.D., B.S., B.Sc., F.R.C.S., Editors. Bristol, John Wright & Sons, Ltd., 1941.

The 1941 edition of this British medical yearbook marks the fifty-ninth year of its publication. Few, if any, of the yearly editions which have preceded the present issue have been produced under conditions more difficult both for the publishers and contributors. In spite of this fact, practically the same contributors have carried on under wartime conditions to produce an Annual easily the equal of its more recent predecessors.

The book consists of 444 pages of text which covers innumerable subjects of interest to a general practitioner, illustrated with thirty-nine plates and eighty-seven figures. In addition, there are seventy-two pages of the Practitioner's Index which covers recent pharmaceutical and dietetic preparations, medical and surgical appliances, etc.

The references to foreign literature, as might be expected, are less numerous, as journals, especially those from the European continent, have not been reaching England.

Although there is but little material actually relating to war surgery, there are excellent chapters dealing with burns and blood transfusion. For the practitioner who desires a precise reference book which deals with most of the conditions he might encounter, the 1941 Medical Annual will prove of great value.

INFANTILE PARALYSIS. A Symposium delivered at Vanderbilt University, April 1941. New York, The National Foundation for Infantile Paralysis, Inc., 1941. $1.25.

This book contains the series of six lectures on anterior poliomyelitis which were given at Vanderbilt University in April 1941. The object was to present, in as concise a form as possible, a statement of much of the present knowledge on the subject, to record new opinions resulting from research and study, and to correct many of the older theories which have held sway, sometimes because they have been accepted by reason of the lack of critical investigation or the necessary knowledge.

The larger part of the volume is devoted to the discussion of the methods and the results of laboratory study, but it includes the consideration of the etiology and the epidemiology, and there is also a chapter on the general treatment, particularly the orthopaedic treatment, of this disease and its sequelae. The work is covered by the following subjects:

"History of Poliomyelitis up to the Present Time"
"The Etiology of Poliomyelitis"
"Immunological and Serological Phenomena in Poliomyelitis"
"The Pathology and Pathogenesis of Poliomyelitis"
"The Epidemiology of Poliomyelitis"
"Treatment and Rehabilitation of the Poliomyelitic Patient".

To those who are interested in a statement of much of the recent work by many scientific observers, which indicates how far the widespread investigation and study have advanced our knowledge, this volume will be found most satisfactory.

THEORY OF OCCUPATIONAL THERAPY FOR STUDENTS AND NURSES. Norah A. Haworth, M.A. (Cantab.), M.R.C.S., L.R.C.P., D.P.M., and E. Mary MacDonald. Baltimore, The Williams & Wilkins Company, 1941. $2.00.

This book is probably intended to be descriptive rather than instructive, for occupational therapy has advanced so far, and has increased its field of application and developed the means and methods of application to such an extent, that a book of this size could not attempt more. There is an interesting history of the beginning and of the growth of occupational therapy, which dates it back rather farther than is usually considered. A discussion is also included of the mental and physical conditions in which this therapy finds its special use. However, the advisability of incorporating in a book of this kind the discussion of the pathology of these diseases, particularly the mental diseases, might be questioned. The products of occupational therapy, which are available in the treatment of those conditions in which it is adapted, the equipment which is used in the schools for the training of the pupils, as well as the materials to be selected in dealing with the patients, are very well illustrated, and suggestions are given as to the choice of application to these same pathological conditions. The reader is given an excellent idea of the practical use of this therapy, also of its development and the state to which it has progressed up to this time, and the very wide acceptance which has been accorded to this method of treatment.

THE MARCH OF MEDICINE. New York Academy of Medicine Lectures to the Laity, 1940. New York, Columbia University Press, 1941. $2.00.

The present-day custom of enlightening the public with respect to matters of medical and public-health interest deserves to be encouraged. The advantages of doing this accrue to the medical profession as well as to the laity. The New York Academy of Medicine is to be commended for giving a wider publicity to this group of lectures through their publication in book form. Each one of them gives in a concise and nontechnical form the high lights of the topics discussed. They are interesting to a medical reader, and informative to the uninitiated. It would be difficult to single out any one as outstanding. They are all extremely well done. It seemed a little unfortunate that Hans Zinsser's contribution to our knowledge of the viruses was not even mentioned. To this reviewer the lectures on "The Inheritance of Mental Disease", "The Story of Our Knowledge of the Blood", and "The Ascent from Bedlam" were the most interesting. This volume should find a place in every medical library, public and private.

ÜBER DIE BEHANDLUNGSERGEBNISSE BEI SCHWEREREN FERSENBEINBRÜCHEN (The Results of Treatment in Serious Fractures of the Calcaneum). Albert Ahlberg. *Acta Chirurgica Scandinavica*, LXXXIV, 187, 1940.

Of 122 fractures of the calcaneum, which the writer followed for over five years, 60 per cent., or ninety-five fractures in eighty-eight patients, were of the severe type, grouped

by Böhler as V to VIII. The author noted that in none of these cases was there anatomical restoration of the fragments with any of the various types of treatment, and that in only six was there normal motion of the subastragalar joint. The degree of mobility seemed to be unrelated to the accuracy of anatomical restoration of the joint surfaces; and joint changes seemed to be dependent on the nature of the fracture, irrespective of the method of treatment. The writer agrees with the opinions which he finds in the literature,—that subastragalar arthrodesis should be performed after four to five months, if symptoms persist.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

FRACTURES OF APPARENTLY HEALTHY BONE WITHOUT UNQUESTIONABLY TRUE ELEMENT OF ACCIDENT. Abraham Troell, Gunnar Lauritzen, and Arnold Möller. *Acta Chirurgica Scandinavica*, LXXXIV, 226, 1940.

Six cases are reported in which muscular violence without external trauma caused a fracture in a roentgenographically normal bone. They comprise an impacted fracture of the radial neck in a girl of eleven years; fracture of the lateral malleolus in a man of fifty-three years; two fractures of the ulna in women twenty-three years old; and fractures of the seventh cervical and first thoracic spinous processes. The writer reviews the literature and concludes that prolonged or sudden heavy strain on a single part of the body, particularly in the face of exhaustion or lack of familiarity with the task, may cause spontaneous fracture of almost any bone in the body, even though there is no external violence. The writer concludes that such fractures should be considered accidents and should be compensated as such.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

TREATMENT OF ARTHRITIS DEFORMANS OF THE HIP BY RESECTION OF THE OBTURATOR NERVE. N. Blixenkrone-Møller. *Acta Orthopaedica Scandinavica*, XI, 11, 1940.

The obturator nerve was resected extrapelvically in sixteen cases in which there were degenerative changes of the hip. Nine of these were cases of true arthritis deformans. Dramatic relief of symptoms was obtained in three cases and slight relief in two. The improvement took place in those cases associated with adduction contracture. In seven of the cases the degenerative changes followed congenital dislocation of the hip, coxa plana, etc. In only one of these was there any benefit from the operation. The writer suggests that resection of the obturator nerve be reserved for cases of true arthritis deformans with adduction contracture.—*Walter P. Blount, M.D., Milwaukee, Wisconsin.*

CAUSALGIC BACKACHE. Otho C. Hudson, Carl A. Hettesheimer, and Percival A. Robin. *American Journal of Surgery*, LII, 297, May 1941.

The authors describe a type of back pain that involves the lumbar muscles, especially the quadratus lumborum. This pain is due to irritation of the twelfth thoracic and first lumbar nerves and radiates along the twelfth rib. A clinical picture of asymmetrical muscle imbalance occurs. This group of cases make up another definite clinical entity, which can be separated from that vast group of patients suffering from back pain. The treatment is simple and effective.

This type of backache is produced by muscle imbalance and muscle spasm, which increase the tension within the quadratus lumborum fascia with direct pressure on the twelfth thoracic nerve, as in the scalenus anterior syndrome. The irritation is manifested by pain with radiation along the course of this nerve. The abdominal muscles become weakened by lack of use, and the overworked sacrospinalis muscles become contracted with an increase of lumbar lordosis and anterior inclination of the pelvis.

The history given by the patient is quite characteristic. It is the history of low-back pain of several years' duration, which is localized in the crest of the ilium and is unilateral. If the pain is right-sided, in many cases appendectomy, gall-bladder surgery, or urological instrumentation have been resorted to without relief. The discomfort continues at night as well as during the day.

Examination reveals increased lumbar lordosis, postural scoliosis, and tilting of the pelvis with abduction of the lower extremity, internal rotation of the thigh, and marked pronation of the foot. There is often hyperaesthesia over the cutaneous distribution of the twelfth thoracic and first lumbar nerves. Tenderness along the twelfth rib is elicited. Tenderness and hyperaesthesia are observed parallel to Poupart's ligament, the upper inner aspect of the thigh, and paravertebrally over the twelfth thoracic and first lumbar transverse processes.

The treatment is rather simple and consists of raising the heel of the abducted extremity to overcome the pelvic tilt. This relaxes the quadratus lumborum and allows the rib to return to normal position, resulting in correction of the scoliosis and disappearance of the internal rotation of the thigh. Exercises for the development of the abdominal muscles and the sacrospinalis group are given.—*O. C. Hudson, M.D., Hempstead, New York.*

CRITIQUE ON THE INTER-RELATIONSHIPS OF THE OSTEOGENIC TUMORS. Sheldon A. Jacobson. *The American Journal of Cancer*, XL, 375, 1940.

Under the above title the author presents an elaborate analysis of the various theories of the histogenesis of bone tumors, and offers his own classification, based upon tissues of origin. The classification is developed according to the following scheme:

TISSUE OF ORIGIN	BENIGN TUMOR	MALIGNANT TUMOR
Notochord	Chordoma	
Undifferentiated connective tissue		
Periosteum	Fibroma	Fibrosarcoma
Medullary stroma	Fibroma	Fibrosarcoma
Narrow fat	Lipoma	Liposarcoma
Cartilage	Enchondroma	Chondrosarcoma
Skeletoblastic mesenchyme		
Perichondrium	Ecchondrosis	Chondrosarcoma Osteogenic sarcoma (chondroplastic type)
Periosteum of enchondral bones	Cartilaginous exostosis	Chondrosarcoma Osteogenic sarcoma (variable type)
Periosteum of membranous bones	Ivory exostosis	Osteogenic sarcoma (osteoplastic type)
Endosteum	Osteoid osteoma Giant-cell tumor	Osteogenic sarcoma (osteoplastic type)

The classification is compared with others in the literature in a critical review. An extensive bibliography is appended.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

THE MANAGEMENT OF SCOLIOSIS. Frederick vom Saal. *The American Journal of Surgery*, LII, 433, June 1941.

Etiological factors in the various types of scoliosis are discussed as paralytic, idiopathic, thoracogenic, neuropathic, and congenital. In the treatment of the postpoliomyelitic curves, it was found that if the curve was progressing before application of the brace, it would continue to do so after application of the brace. The majority of curves in the idiopathic group stopped progressing before cessation of growth. Fusion was done in forty-one patients in a group of 174 with the various types, the patients with postpoliomyelitic scoliosis predominating. Many of these will need fusion for the prevention of deformity. The author uses the Risser type of jacket, with certain modifications. The

jacket is applied with the patient in the maximum bending position toward the concave side of the primary curve, thus straightening the compensatory curves, producing one long curve, and derotating the secondary curves, making the patient straighter and more comfortable. Hinges and turnbuckles are then used for correction. A second modification consists of later rotating the upper part of the cast, so as to bring the shoulder on the convex side of the primary curve forward, after first removing the hinges and turnbuckles. This aids in the correction of rib deformity and brings the spinous processes into a more nearly vertical position—allowing greater ease of operation in the later spine fusion, and better cosmetic results. This does not apply in long-standing cases with severe rotation of the vertebral bodies. The fusion area is determined by studies of the immediately preoperative roentgenogram.

The operation is performed in the usual manner, using the modified Hibbs or Mackenzie Forbes technique, fusing six or seven vertebrae at one time, and using additional bone chips in all cases. Preoperative and postoperative care are discussed.—*Custis Lee Hall, M.D., Washington, D. C.*

Dislocation of the Cervical Spine, Necessitating Fixation at Open Operation. James P. Ainslie. *The Australian and New Zealand Journal of Surgery*, X, 77, 1940.

The author describes a case of forward subluxation of the sixth on the seventh cervical vertebra. The patient had limitation of neck motion, and tingling and pain in the area of distribution of the seventh cervical nerves. With the patient under general anaesthesia and the use of a force of seventy pounds for forty-five minutes, it was impossible to reduce the dislocation. At open reduction the articular facets were levered into place, but, in spite of plaster immobilization, the dislocation recurred after three weeks. This time at open operation, two flanged plates were inserted, which would maintain the reduction even during forcible flexion of the head.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

The Treatment of Recent Fractures of the Neck of the Femur by Subtrochanteric Osteotomy. A. L. Dawkins. *The Australian and New Zealand Journal of Surgery*, X, 244, 1941.

Since it is generally conceded that there are at least 10 to 15 per cent. of failures in hip pinnings from various causes, the author presents a review of the subtrochanteric osteotomy as the treatment of recent fractures of the femoral neck. Union is more likely to occur as a result of the osteotomy; and, even should it not occur, the patient still has a satisfactory hip, except for a slight amount of shortening and inability to adduct the limb beyond the neutral position. The osteotomy is usually just above the level of the lesser trochanter, permitting the shaft to be displaced medially under the head and acetabulum. With the leg in abduction, a single hip spica is used for three months. Since Whitman's method of reduction and immobilization yields only 60 per cent. to 70 per cent. good results, an immediate osteotomy which will bring satisfactory results in almost 100 per cent. of cases is certainly to be preferred.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

Fracture of the Neck of the Femur: Pros and Cons of Nailing. John Hoets. *The Australian and New Zealand Journal of Surgery*, X, 278, 1941.

In younger patients, the author is more inclined to use the Whitman method of reduction and immobilization, whereas in older and more debilitated patients, a nailing is preferable. In the operative technique, good roentgenographic control is most essential, and, where available, it shortens the operative time. The McMurray osteotomy is a procedure to fall back upon in cases of unsuccessful nailing. Aseptic necrosis, arthritis, and non-union are not due to the effects of the nail itself. The author describes

a markedly debilitated woman, sixty-three years of age, who withstood the nailing very well, but in whom marked degenerative vascular disease with gangrene of the feet developed. She died four months following the pinning; yet at necropsy, the femoral neck showed excellent union with restoration of the trabeculae, in spite of the fact that the patient's arteriosclerotic vessels produced a gangrene of both lower extremities.—*Daniel H. Levinthal, M.D., Chicago, Illinois.*

LA PATELECTOMIA EN EL TRATAMIENTO DE LA LUXACIÓN RECIDIVANTE DE LA RÓTULA (Treatment of Recurrent Dislocation of the Patella by Excision of the Knee Cap). Oscar R. Marottoli. *Boletines de la Sociedad de Cirugía de Rosario,* VII, 223, 1940.

This is a very excellent presentation of the subject of recurrent dislocation of the patella. The author believes that it is an anatomical alteration in the structure of the knee joint which allows this displacement of the patella. He feels that the patella is a bone which is gradually being done away with in the evolutionary process of man, and that it is therefore of no use and can be resected with impunity. The various mechanical factors which play a part in the dislocation of the patella are discussed. The author has made tests of muscle strength on patients who have had their patellas removed, and he feels that the strength of the leg is not decreased at all by this operation. The author's technique for removal of the patella is described in detail, and it consists in simply excising the bone, and repairing the defect by stitching the aponeurosis across on each side, and then the quadriceps and patellar tendons. He presents six patients whom he has treated by this method, several of whom have been followed for well over a year. The end results in all of the cases have been excellent, the patients having strong knees and no tendency to any further trouble. The case histories and follow-ups are presented in detail. The article is illustrated with excellent photographs showing the end results in the patients treated. The article offers another and apparently very useful operative procedure for the treatment of recurrent dislocation of the patella.—*Louis W. Breck, M.D., El Paso, Texas.*

TRAUMATIC EXPULSION OF ASTRAGALUS. H. J. McCurrich. *British Journal of Surgery,* XXVIII, 611, 1941.

This is the history of a boatswain on a steam trawler which struck a mine. The patient was blown into the air and then fell into the water. On examination at the hospital it was found that he had a large gaping wound on the inner side of the foot with rupture of all the tendons, vessels, and nerves. The astragalus was missing. Amputation was done through the lower leg, and the patient recovered.

The mechanism of this dislocation is discussed. In this case it was due to a trauma delivered from below rather than to a fall from a height, which is the usual mechanism.—*E. M. Daland, M.D., Boston, Massachusetts.*

THE RÔLE OF VITAMIN D IN THE CALCIUM METABOLISM IN OSTEOMALACIA. S. H. Liu. *Chinese Medical Journal,* LVII, 101, 1940.

The author observed that the fundamental defect in osteomalacia is due to excessive loss of calcium through the gastro-intestinal canal. The amount of calcium lost by this method may not be great on the daily basis, but if such a loss occurs for a period of time, skeletal decalcification will result. The disease may also occur during periods of increased demand for mineral, especially during pregnancy or lactation. The author feels that disturbance in absorption of calcium in the intestinal tract is due to vitamin-D deficiency. After administration of vitamin D, intestinal absorption of calcium improves, with a decrease of calcium output in the stool and urine. Seven cases have been treated by vitamin D in the form of vigantol, and a high-calcium diet. Most of the patients showed marked improvement.—*Fuang Satyasnguan, M.D., Iowa City, Iowa.*

CONGENITAL DISLOCATION OF THE RADIUS. C. M. Meng. *Chinese Medical Journal*, LVII, 479, 1940.

From this review of the literature it is seen that congenital dislocation of the radius is a rare condition, seen more frequently in the male, with the posterior variety supposed to be more common. The etiology is unknown. Some believe that defective constriction or development of the radiohumeral joint is of significance. It is also believed that heredity is an important factor in the etiology of this condition. In the treatment, reduction is contra-indicated in the great majority of cases. Pressure necrosis may develop when great pressure has been exerted during the manipulation. Many of these cases require no treatment, but when the function of the elbow is very much limited, resection of the upper end of the radius is the treatment of choice.—*Fuang Satyasnguan, M.D., Iowa City, Iowa.*

TREATMENT OF FRACTURE OF THE PATELLA BY EXCISION. Hou Ch'un-chih. *Chinese Medical Journal*, LVII, 482, 1940.

The author claims that excision treatment of the fractured patella lessens the period of convalescence, so that the patient can return to work earlier—two to six weeks after operation—than when other methods are used. He points out that the knee joint still preserves its normal function after removal of the patella. He also describes the method of operation.—*Fuang Satyasnguan, M.D., Iowa City, Iowa.*

ONE HUNDRED (100) CASES OF ARTHRITIS TREATED WITH A COMPARATIVELY NON-TOXIC GOLD COMPOUND. R. E. Driscoll and D. E. Markson. *Illinois Medical Journal*, LXXVIII, 503, 1940.

The authors cite the work of Mollgaard and Wakerlin who showed that sanocrysin (gold-sodium-thiosulfate), the commonly used gold salt in the treatment of arthritis, is six times as toxic to rabbits as aurol-sulfide, a stable aqueous solution of colloidal gold sulfide. Figured in terms of metallic gold, actually fourteen and one-half units of aurol-sulfide are needed to produce the toxic effects of one unit of sanocrysin. This ratio indicates that colloidal gold sulfide is relatively non-toxic, and larger doses of actual gold may be given in the form of colloidal gold than in the form of crystalloid salts of gold.

The authors treated fifty-one patients with atrophic, and forty-nine with hypertrophic, arthritis by intramuscular and oral administration of aurol-sulfide. These patients were divided into three groups which received varying amounts of gold per patient. Toxic reactions were observed in only two patients, who were also receiving injections of bismuth and arsenic while under the gold-sulfide treatment.

As a result of this treatment, twenty-one patients, or 41 per cent. of the group of fifty-one with atrophic arthritis, and nineteen, or 39 per cent. of the group of forty-nine patients with hypertrophic arthritis, "were definitely improved for the period of this observation". The authors do not state just what this improvement was.

The writers state that this is merely a preliminary report with the primary purpose of ascertaining the degree of toxicity of colloidal gold sulfide. They observed greater improvement when larger doses of gold were used.—*M. S. Friedman, M.D., Iowa City, Iowa.*

SITES OF ELECTION FOR AMPUTATION. (Chapter III of a Handbook on Amputations, in preparation by the Council on Physical Therapy of the American Medical Association.) *The Journal of the American Medical Association*, CXV, 2174, 1940.

This chapter deals with amputations of the lower extremity. Toe amputation results in little or no disability and requires no prosthesis.

Metatarsal amputation sacrifices the normal weight-bearing region of the metatarsal heads. A plantar flap compensates somewhat by retaining soft-tissue integuments

adapted to weight-bearing. Muscular control of the arch is somewhat less efficient, due to loss of the plantar muscles. Leverage and function, consequently, are lost as the site of amputation is moved backwards. Lisfranc's amputation is as far back as one should go. Chopart's amputation is to be condemned as the stump usually goes into an equinus deformity.

Symes' and Pirogoff's amputations require careful surgical technique and neither is likely to succeed in the presence of infection.

The optimum site for amputation of the leg is from five to seven inches below the knee joint.

Amputation through the knee joint has fallen into disuse.

The osteoplastic method of Gritti-Stokes, and the tendinoplastic methods of Callander, and Kirk are satisfactory early, but often come to re-amputation at a later date. They are also difficult to fit with prostheses.

In amputation through the femoral shaft, as much of the bone should be spared as possible.

Disarticulation should be done only as an absolute necessity.

In amputation of the upper extremity as much of the hand should be preserved as possible for later reconstruction.

The forearm should be amputed at the junction of the middle and lower thirds. A terminal scar is satisfactory.—*Maurice Jacobs, M.D., Dallas, Texas.*

EARLY DIAGNOSIS OF MALIGNANT METASTASES TO THE SPINE. A CLINICAL SYNDROME. Samuel A. Wolfson, Samuel Reznick, and Lewis Gunther. *The Journal of the American Medical Association*, CXVI, 1044, 1941.

The authors report seven cases of malignant metastases to the spine with especial emphasis upon the importance of an early diagnosis and the methods of obtaining it. They believe that it is possible to obtain a definite clinical diagnosis in many cases long before roentgenographic evidence is available. A triad of diagnostic criteria is presented: (1) the appearance of radicular pain, persistent and increasing, limited to a narrow zone supplied by one or two roots, and associated with deep percussion tenderness over the spinous processes of the vertebrae bounding the interspaces through which these roots emerge; (2) elevation of the erythrocyte sedimentation rate which appears early, even before changes in the hemogram, and which does not vary proportionately with the amount of marrow involvement; and (3) an increase in the serum-phosphatase level. The authors point out that serial serum-phosphatase determinations may show a significant progressive increase, even though at first examination the values were nearly normal.

Thus, any case in which these criteria are fulfilled may be strongly suspected to be a metastatic lesion of the spine, and, in the presence of a known primary lesion, the diagnosis may be definitely established in the face of negative roentgenographic evidence.

The importance of roentgenotherapy in the relief of symptoms, retardation of the process, and prolongation of life renders such early diagnosis imperative.—*S. L. Stovall, M.D., Dallas, Texas.*

CALCIFICATION OF THE SUPRASPINATUS TENDON. A NEW TREATMENT. G. F. Dick, L. W. Hunt, and J. L. Ferry. *The Journal of the American Medical Association*, CXVI, 1202, 1941.

The authors in this article discuss the etiology, symptoms, and physical findings in calcification of the supraspinatus tendon, and present a new method of treatment which they have found beneficial in several cases.

Contrary to the popular theory that calcification is due to frequent trauma, the authors express the view that calcification may be due to some other factor, namely, a focus of infection. Although this theory is unsupported, symptoms have subsided following removal of focal infections.

The symptoms and physical findings vary with the onset, whether acute or chronic. In both types there is usually pain over the apex of the shoulder, which radiates down the anterior aspect of the arm or to the side of the neck. In the acute form there is considerable muscle spasm, associated with a varying degree of limitation and external rotation. It is emphasized that failure of roentgenographic examination is due to improper placement of the tube.

In the treatment of these individuals surgery is questionable, and excellent results have been obtained by medical management which consists in (1) relatively large doses of ammonium chloride, (2) rest of the diseased part, and (3) physiotherapy and the removal of foci of infection. Ammonium chloride lowers the hydrogen-ion concentration of the blood, thus causing an acidosis of mild degree which in turn causes an absorption of calcium from the tendon. It is given in doses of one gram or more four times a day. Rest of the part is assured by a properly applied arm sling during the day, and by resting the arm on a pillow in abduction at night. Physiotherapy should consist in diathermy. All foci of infection, for example, tonsils, dental infections, prostatitis, et cetera, should be removed.—*S. L. Stovall, M.D., Dallas, Texas.*

PREVENTION AND TREATMENT OF INFECTIONS OF THE HAND. Sumner L. Koch. *The Journal of the American Medical Association*, CXVI, 1365, 1941.

In reviewing and summarizing the results of treatments of open hand wounds sustained by workers in a manufacturing plant located approximately one mile from the hospital with which he is affiliated, the author found that there were sixty-nine such injuries in the past six years. The first-aid rules of the manufacturing plant were followed.

Of forty-seven of these patients who arrived at the hospital immediately after trauma, the injury of only one failed to heal by primary intention and without infection. There were twenty-three patients in whom infection occurred, and in every instance, except the one just mentioned, the employee had failed to report until an average period of three days after the injury.

The author stresses the point that all wounds should be cared for at the time of accident by placing only a sterile dry dressing over the wound, and sending the patient immediately to the hospital.

The first question in regard to infections is whether the infection is diffuse and spreading or localized. After correct diagnosis, it is treated accordingly. All injured tissues should be splinted; this is usually best done by a light aluminum splint which can be molded into desired shape and can be sterilized and incorporated into the dressing.—*D. K. Barnes, M.D., Dallas, Texas.*

MULTIPLE HEMANGIOMAS OF BONE, PROBABLY CONGENITAL. John W. Pierson, George Farber, and John Eager Howard. *The Journal of the American Medical Association*, CXVI, 2145, 1941.

Diffuse osteolytic lesions of the skeletal system are often among the clinician's most difficult diagnostic problems. Even microscopic examination of biopsy material may be inconclusive for exact diagnosis. A patient was recently seen with widespread lesions in which the correct diagnosis was established only by biopsy. The patient was a white male who, from all physical and clinical evidence, was normal except for the roentgenographic findings throughout his entire skeletal system, with the exception of the areas below the knees and below the left elbow. A very thorough and complete examination, including a vast amount of laboratory work, failed to reveal any abnormality.

Diagnosis was made by biopsy of a rib. Differential diagnosis must rule out xanthomatosis diffuse, and osteitis fibrosa cystica (hyperparathyroidism), and osteitis fibrosa disseminata. The one question of most importance to the patient is whether the condition is progressive or not. In the case reported there had been no progression over a five-year period.—*D. K. Barnes, M.D., Dallas, Texas.*

AMPUTATION IN CONGENITAL AND CHRONIC DISABILITIES. Council on Physical Therapy. *The Journal of the American Medical Association*, CXVI, 2159, 1941.

Almost every community contains one or more persons severely crippled by chronic disability, either congenital or acquired, for whom the question of amputation has to be considered. Most of these cases can be classified under any one of the four headings: (1) congenital deformity, (2) posttraumatic deformity, (3) paralysis, and (4) infections.

The Council on Physical Therapy has made it very clear that amputation is a suitable procedure in many cases, but it must be given thought in all cases; this also applies to reconstructive work. There should be sufficient far-sightedness before subjecting the patient to many operative procedures, to judge whether or not the patient will be truly benefited.—*D. K. Barnes, M.D., Dallas, Texas.*

THE KENNY TREATMENT OF INFANTILE PARALYSIS. A PRELIMINARY REPORT. Wallace H. Cole and Miland E. Knapp. *The Journal of the American Medical Association*, CXVI, 2577, 1941.

The authors make a preliminary report on the treatment of twenty-six patients with acute anterior poliomyelitis as carried out by Miss Elizabeth Kenny under their observation. Of this number twenty received the Kenny treatment within two weeks of onset. Eleven have already been discharged completely normal, and it is expected that five of the others will recover completely within a reasonably short period of time. One has paralysis of both legs which will probably be permanent.

Of the six patients on whom the Kenny treatment was started from two weeks to two months after the onset of the disease, two have been discharged as permanently well, one will probably have permanent paralysis of one arm, and two are quite likely to have some degree of permanent paralysis.

The principle of the treatment is to combat the muscle spasm, muscle incoordination, and mental alienation which Miss Kenny believes are the cardinal symptoms of the disease. No splints or casts are used. Especially prepared hot foments are applied until the muscle spasm has disappeared. Passive movements through the range of motion possible without pain are carried out several times a day. In addition, an attempt is made to maintain awareness of the part by training once or twice a day as soon as muscle spasm is sufficiently reduced. As the pain is reduced, the muscle training is increased to maintain normal nerve pathways and to restore those which are damaged. By the time the patient is ready to be released from the contagious ward, the pain and spasm are usually gone. Periods of muscle training are carried on twice a day until the patient is normal or ready to be discharged from treatment.—*Brandon Carrell, M.D., Dallas, Texas.*

COMPRESSION TREATMENT OF CRUSH INJURIES OF LIMBS. David H. Patey and J. Douglas Robertson. *The Lancet*, I, 780, June 21, 1941.

The authors report on their experiences in treating crushing injuries of the extremities during bombings of civilian areas. They point out that crushing injuries are often followed by a syndrome consisting of shock, oedema of the affected limb, oliguresis or anuresis, and generally death. They question that this syndrome is due to the liberation of toxic bodies from the crushed tissues and suggest that the reverse may be true, in that on the release of the pressure there is a loss of blood constituents into the injured limb. On this hypothesis they treated two cases by applying intermittent positive pressure up to sixty millimeters of mercury to the oedematous area, using a special large blood-pressure cuff and a pavaex motor. In both cases there was an increase in the output of urine, a diminution of the oedema, and satisfactory recovery. The authors recommend that the treatment be given further trial in crushing injuries and in cases where tourniquets have inadvertently been left too long in position.—*Lenox D. Baker, M.D., Durham, North Carolina.*

LOCAL CONCENTRATION OF SULPHONAMIDE COMPOUNDS INSERTED INTO WOUNDS. Frank Hawking. *The Lancet*, I, 786, June 21, 1941.

The author describes an investigation of the concentration of sulphonamide compounds: (a) in the wound cavity adjacent to the drug deposit, (b) in the distal parts of the wound cavity, and (c) in the living and dead tissue forming the sides of the wound. He concludes that sulphanilamide has the advantage of high local concentration (maximum about 1500 milligrams per 100 milliliters) and of greater powers of penetration and diffusibility, but the disadvantages of rapid disappearance from the wound and of lower bacteriostatic activity against many of the organisms which may be present. Sulphathiazole persists for a longer period in the wound, and its bacteriostatic activity is much higher than that of sulphanilamide, but it has the disadvantages of expensiveness, of lower concentration (maximum about 180 milligrams per 100 milliliters), and of lower diffusibility. Sulphapyridine possesses no advantage compared with the sulphathiazole, but has the disadvantage of producing still lower concentrations. It is concluded that if a sulphonamide compound is placed in the central cavity of the wound it will pass outward into the prolongations of the cavity, and it will slowly diffuse into dead tissue, but it will not penetrate more than a few millimeters into tissue with an intact circulation. Such tissue is reached more quickly and more effectively by oral administration, as the local application of each of these compounds is limited to the immediate vicinity of the wound cavity.—*Lenox D. Baker, M.D., Durham, North Carolina.*

AIR RAID EXPERIENCES IN THE EAST END OF LONDON. Thomas F. Rose. *The Medical Journal of Australia*, II, 690, 1940.

This is an intensely interesting account of the injuries treated by the author during the first month of the bombing of London. Of the 128 cases admitted, twenty-four were orthopaedic in nature. The most serious were compound fractures and perforating joint wounds. All of these were due to crushing by pieces of masonry, concrete, or stones, with much destruction of muscle and skin. There were no limb injuries due to metal flakes from the small shrapnel bomb common in the Spanish Civil War.

Complicating some of these cases were lung blast and crushing injury to the chest. In the former condition the patient did not have signs of lung damage until twenty-four hours after the bomb explosion. The cases of peripheral-nerve paralysis were caused by the concussion effect of blows from flying objects.

The Orr type of treatment was used for the compound fractures. This method has been popularized by Trueta in the late Spanish War. In perforation of joints a thorough débridement was done, and vaselin gauze was packed into the cavity. Non-padded plaster casings were then applied. In all shrapnel wounds the same type of vaselin packing was done, and no closure was attempted. All of the patients were given 3000 units of tetanus antitoxin. In addition, the routine administration of sulfapyridine was carried out as soon as possible following operation. No case of tetanus, gas gangrene, or severe infection developed in this series of patients.—*Harold M. Childress, M.D., Charleston, South Carolina.*

LOCAL IMPLANTATION OF SULPHANILAMIDE FOR THE PREVENTION AND TREATMENT OF GAS GANGRENE IN HEAVILY CONTAMINATED WOUNDS: A SUGGESTED TREATMENT FOR WAR WOUNDS. N. J. Bonnin and Frank Fenner. *The Medical Journal of Australia*, I, 134, 1941.

This experimental work was done upon guinea pigs while the authors were in training with a field ambulance corps of the Australian Imperial Force. Treatment was applied in a way which would be practical in war.

Nearly all research workers during the past several years have found that local implantation of sulphanilamide in early compound fractures has either prevented or greatly delayed infection. There is no local irritation, and the consensus of opinion is that the

drug produces no tissue damage. Consequently it does not interfere in any way with the normal healing. This latter opinion was confirmed by the authors by making deep incisions upon guinea pigs and then packing them with the powdered drug. No deleterious effects were noted. Virulent cultures of gas-gangrene organisms were used to infect other fresh wounds. In the treated animals, five-tenths of a gram of powdered sulphanilamide was packed into the wound.

Results showed that locally administered sulphanilamide will control infections with clostridium welchii and clostridium septique, but has only a slight delaying effect on clostridium oedematiens. With mixed infections, surgery combined with the drug gave excellent results.

The authors suggest a routine treatment for war wounds. About twenty grams of the drug should be carried by each soldier. Upon being injured, he should pour the powder into the wound before the first dressing is applied. At the casualty clearing station proper débridement and indicated surgery would then be done.—*Harold M. Childress, M.D., Charleston, South Carolina.*

PARALYSIS OF THE SERRATUS ANTERIOR MUSCLE COMPLICATING DISLOCATION OF THE SHOULDER. George C. V. Thompson. *The Medical Journal of Australia*, I, 231, 1941.

The frequency of nerve injuries complicating dislocation of the shoulder has been estimated to be from 4 per cent. to 55 per cent. Watson-Jones has stated that such sequelae appear in about 14 per cent. of such dislocations. The author has had in the past three months six cases of nerve lesions in thirteen patients having dislocated shoulders.

The neural injury is produced by traction upon the brachial plexus or by direct trauma to an isolated nerve. The axillary nerve is particularly liable to injury because of its exposed course, as is the long thoracic nerve. The writer reports one case of the latter with a consequent paralysis of the serratus anterior muscle. The end result was not known, as the patient refused to submit to prolonged conservative treatment.

A detailed discussion of causes, diagnosis, and treatment of other forms of anterior serratus palsy is given.—*Harold M. Childress, M.D., Charleston, South Carolina.*

ZUR BEHANDLUNGSTECHNIK DER SUPRAKONDYLÄREN HUMERUSFRAKTUR (Treatment of Supracondylar Fracture of the Humerus). K. Schroeder. *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, XLVIII, 52, 1941.

In a case of supracondylar fracture of the humerus in a child, seven years old, the author was unable to obtain a satisfactory reduction by the customary method of manipulation. He then resorted to a procedure of circumduction of the fragments, by which the lower fragment was displaced from the posterior to an anterior position. With this relationship of the fragments, it was very simple to obtain a proper reduction, which resulted in complete function of the elbow after three months of treatment.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

COXA PLANA. Donald B. Slocum. *Northwest Medicine*, XL, 233, July 1941.

The author considers coxa plana to be not a disease, but a self-limited syndrome. It is believed to be an aseptic necrosis, resulting from an interference with the blood supply to the epiphysis. This causes a stoppage of growth, and the continuing growing trochanter results in an apparent coxa vara. Of sixty-eight patients, males were four times more numerous than females. The average age was eight and twenty-one hundredths years.

The treatment recommended is conservative, plus a general health-building program. The patient is kept recumbent with traction during the first two stages in recovery,—that is, the stage of condensation and the stage of fragmentation. It is not until

he is well along in the third stage—that of healing—that he is allowed up with braces which prevent weight-bearing completely. This prolonged conservative treatment will provide the differential diagnosis from tuberculosis. No surgical short cut has yet been found to be advisable, although surgery may be performed in the third stage.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

TROCHANTERIC FRACTURES OF THE FEMUR. W. B. McKibbin. *Northwest Medicine*, XL, 242, July 1941.

A method is described of holding trochanteric fractures, especially those fractures in which extensive fragmentation has taken place, and where pins through the neck and head alone are insufficient. The author passes two pins into the neck and femoral head, and these, together with a Roger Anderson half-pin unit inserted below the area of fracture, are all rigidly clamped to a bar and enclosed in a plaster cuff encasing the femur. The knee need not be enclosed. The patient is early mobilized.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

PRIMARY TREATMENT OF WAR WOUNDS. M. N. Akhoutin. *Novy Khirurgichesky Arkhiv*, XLV, 195, 1940.

The method of primary surgical treatment of field wounds was worked out toward the end of the last century. It was then understood as a wide opening of the wound. Pirogoff emphasized the importance of deep incisions with indispensable opening of muscular fasciae. Later on, Bergmann widened the meaning of primary treatment by adding to the technique of incisions the removal of blood clots, foreign bodies, necrosed tissues, and counter incision for drainage. In 1898, Friedreich proved that for six hours the micro-organisms remain within the confines of the wound, and introduced the method of débridement. In the Russo-Japanese war of 1904 to 1905, when 76 per cent. of injuries were from bullet wounds, the method of primary treatment was not used. The World War, with a preponderance of shell wounds, gave an impetus to the forgotten débridement. Friedreich's findings were experimentally confirmed by the French surgeons, and executed with a high degree of success. The method consisted in a complete excision of the wound with subsequent primary suture. Since then, the method has found a very wide application in wounds of civil life in the Soviet Union where primary healing has been reported in 90 per cent. of several thousand cases.

However, adherence to a very exacting technique is essential. The author had the opportunity to observe results of treatments without due consideration to indications in the battles of the Far-Eastern armies. Disastrous results were observed when the time limit of six to eight hours was not observed and when the wound, after a seemingly thorough excision, was closed without drainage.

The author indicates the physical impossibility of excising the wound properly under battle conditions, in which the steady and large numbers of wounded precludes the possibility of a thorough excision as practiced in civilian hospitals. Even if all the prerequisites for a successful débridement were present, the application of sutures would be impossible in all through-and-through wounds with multiple fractures of bone.

The author considers also the wounds of the skull, abdomen, and chest, and indicates the proper management of these wounds.

In order to avoid the mistakes of misapplied débridement in treatment of the extremities, rigid instructions were issued to the field surgeons. The instructions called for a thorough débridement with an economical excision of the skin, removal of all foreign bodies and free fragments of bone, application of a solution of chloramine or rivanol, and immobilization of the extremity. In the presence of joint wounds with fractures, excision of the joint is indicated. Where the soft tissues only are involved, a primary suture of the capsule can be effected, but the skin should not be sutured. The use of antianaerobic sera was apparently not satisfactory.

The author notes the very efficient organization of blood transfusions. More than 7 per cent. of all the wounded received transfusions, and this included almost all of the wounded who needed transfusions.—*Emanuel Kaplan, M.D., New York, N. Y.*

LE TRAITEMENT DES MOIGNONS D'AMPUTATION DOULOUREUX (The Treatment of Painful Amputation Stumps). E.-P. Leclerc. *La Presse Médicale*, XLVIII, 667, 1940.

The author calls attention to the fact that painful amputation stumps may in general be classified into three types,—those characterized by: (1) pain in the stump, itself; (2) pain in the amputated limb; and (3) pain of both types.

Those in the first category are due to painful neuroma, periosteal changes in the bone, etc. Following the lead of Leriche, the author strictly advises against reamputation or plastic surgery of the nerve. Though novocain injection has proved of value, the author urges that the patient should be advised of the possible return of the symptoms. In that event, exposure of the nerve, injection with phenol, amputation of the neuroma, and prompt resuture of the nerve are advocated. However, even in this type of case considerable improvement has been obtained by the procedure which is specifically indicated for cases falling into the second category.

This second group is that in which the patient experiences exquisite pain in the amputated member. Periarterial sympathectomy and novocain injection are of but little avail. It is recommended that preliminary injection of novocain into the lumbar ganglia, in the case of the inferior extremity, or into the stellate ganglia, in the case of the superior extremity, be undertaken for this purpose. If relief of pain is experienced, the author recommends ganglionectomy as the procedure of choice.

In the mixed group the first operation should consist of ganglionectomy, since in itself it may serve to eliminate both the local pain and the radicular pain. A suitable interval should be permitted to elapse between the performance of the ganglionectomy and the amputation of the neuroma, if the second operation is indicated.—*Henry Milch, M.D., New York, N. Y.*

TECHNIQUE DU TRAITEMENT GALVANIQUE DANS LA PARALYSIE INFANTILE (Technique of Galvanotherapy in Infantile Paralysis). H. Bordier. *La Presse Médicale*, XLVIII, 746, 1940.

Physiotherapy in the treatment of acute anterior poliomyelitis consists in the use of radiotherapy, diathermy, and galvanotherapy. In regard to this latter modality, the present technique of immersing the affected part in an electrode bath is completely bad. Employed in this fashion, the galvanic current acts by preference upon the healthy muscles, whose electric resistance is less than that of the involved muscles.

In order to achieve the best results, the author suggests that the parent be instructed to carry out the treatment. For this purpose he has had constructed a portable dry battery, capable of delivering from eight to ten milliamperes of current at a voltage varying from zero to forty-five volts. Because the conductivity of heated muscle is greater than that of unheated muscle, the author suggests a preliminary period of diathermy. The indifferent electrode should be about 100 square centimeters and should be applied at the base of the affected limb. The active electrode should be about twenty square centimeters and should be applied by preference over the affected muscles or their respective motor points. Whether the active electrode should be connected to the positive or the negative pole will be determined by the electrodiagnostic tests. If the muscle exhibits a complete reaction of degeneration, with predominant response on anodal closure, it is to this pole that the active electrode should be connected.

Treatments should be given daily for ten minutes to each segment of the affected limb.—*Henry Milch, M.D., New York, N. Y.*

CONSIDÉRATIONS SUR L'OSTÉODYSTROPHIE RÉNALE. A PROPOS D'UNE OBSERVATION NOUVELLE (Considerations on Renal Osteodystrophy). Pierre Guye et Erwin Rutishauser. *La Presse Médicale*, XLVIII, 1035, 1940.

The authors report a case of polycystic kidneys in which complete studies including autopsy were made. They note that the nephropathies give rise to a generalized skeletal affection which morphologically resembles the fibrous osteodystrophies. These conditions present appearances seen in hyperparathyroidism, hyperthyroidism, diabetes, and metallic poisoning. All are characterized by an osteolysis, fibrous replacement, and efforts at reparative sclerosis. They are indeed the manifestations of a "demineralization", the exact mechanism of which is not understood.

Attention is called to the fact that von Recklinghausen's disease and renal osteodystrophy may be distinguished by blood chemistry studies. The former is characterized by hypercalcemia and hypophosphatemia, the latter by hypocalcemia and hyperphosphatemia.

Attention is called to the additional fact that though the skeletal lesions are generalized, there may be only local roentgenographic manifestations of the disease. This may be attributed to small traumata such as may be exercised by muscle pull, etc.—*Henry Milch, M.D., New York, N. Y.*

ROENTGEN DIAGNOSIS OF POSTERIOR DISLOCATION OF THE SHOULDER. Richard A. Rendich and M. H. Poppel. *Radiology*, XXXVI, 42, 1941.

This paper calls attention to the infrequency of posterior dislocations of the shoulder and the difficulty both of the clinical diagnosis and of their recognition in roentgenographic projection made in the anteroposterior plane.

Stereoscopic views are a basic requisite, and a vertical or axial view is of great value. In this dislocation, the lesser tuberosity is rotated and brought into extreme profile medially, at the posterior lip of the glenoid fossa, while the lower third of the fossa is exposed. The humeral head will be found directed posteriorly and medially.—*Edward N. Reed, M.D., Santa Monica, California.*

THE MEASUREMENT OF THE DEFORMITY OF ALIGNMENT ACCOMPANYING FRACTURE. Clayton R. Johnson. *Radiology*, XXXVI, 100, 1941.

This paper outlines a system of measurement for accurately describing the deformity accompanying fracture. Its application to fractures of the wrist, knee, ankle, calcaneum, and shafts of long bones, is illustrated.—*Edward N. Reed, M.D., Santa Monica, California.*

MONOMELIC MEDULLARY OSTEOSCLEROSIS OF UNKNOWN ETIOLOGY. Thomas Horwitz. *Radiology*, XXXVI, 343, 1941.

This is a hitherto unclassified skeletal lesion, monomelic, asymptomatic, unassociated with deformity or alteration in the length of the involved bones. There are no changes in non-osseous structures, and the laboratory findings are normal.

The lesion is a diffuse osteosclerosis, limited almost exclusively to the medullary portion of the bone. The sclerosis extends as far as the articular surfaces, but there is no joint involvement. Histologically the normal spongiosa is replaced by densely sclerotic bone consisting of compact, irregular segments of immature and adult bone arranged in a bizarre pattern. The etiology is unknown, but believed to be a congenital or developmental disturbance of the primitive osteoblastic mesenchyme. One case is described. The condition is differentiated from (1) melorheostosis Léri, a cortical involvement with much periosteal reaction; (2) Paget's disease, in its endosteal form which has characteristic periosteal involvement; (3) the osseous changes in caisson disease; (4) neurofibromatosis; and (5) other osteosclerotic lesions.—*Edward N. Reed, M.D., Santa Monica, California.*

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